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Chemical Engineering

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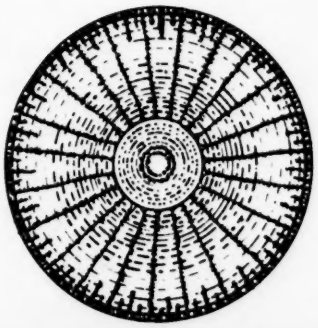

NEW GUIDE TO SELECTION AND USE OF FILTER AIDS

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MONITORED COEFFICIENTS TELL WHEN TO CLEAN TUBES

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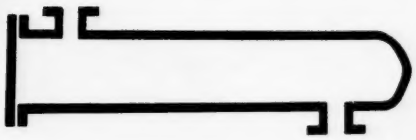

HOW TO PREDICT COMPOSITION OF TERNARY AZEOTROPES

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PROFESSIONALISM—WHAT'S AHEAD FOR CHEMICAL ENGINEERS?

PAGE 166

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HOW GOOD A PUMP DETECTIVE ARE YOU?

Each impeller above is made of Worthite, an austenitic chromium-nickel-molybdenum stainless steel. Each was selected for its corrosion and abrasive resistance to the fluid being pumped. Each was in a pump correctly selected for the hydraulic problem to be faced. But each wore out long before necessary. Can you tell why by looking at the impellers?

In figure No. 1, the impeller handled lime mud in a paper mill. The deep gouges are caused by large chunks of lime. The feathered edges are caused by churning in the mud at start-up and when the suction tank was almost empty. Agitation of the liquid in the suction tank and by-passing solved the problem.

In figure No. 2, the Worthite impeller handled 65% potash slurry from the bottom of a thickener. It lasted 3 months. The percentage of solids was too high and the pump was operating at too high a capacity. By operating nearer the maximum efficiency and with a slight reduction in solids, the life of the impeller was more than doubled.

In figure No. 3, the impeller handled fine (48 mesh) potash slurry with some sharp sand. The pump flow was controlled by throttling the suction. By eliminating throttling of suction and installing a by-pass, impeller life was increased from one to about four years.

In figure No. 4, the pump delivered 50% by weight slurry to a plate and frame filter press. As the filter filled up, the pump operated back toward shut-off, causing wear on the outer third of the impeller vanes. The solution was to shut the pump down when adequate filter cake had been built up, but before the pump began to operate against shut-off. Impeller life increased three times.

Now, why did the impellers wear out long before necessary? It wasn't impeller material or pump selection. It *was* the system on which the pump was used. Seemingly small factors in installation or operation prevented achieving the full economy promised by Worthite in handling corrosive-abrasive fluids.

At Worthington we have been through these and virtually every other pumping problem. With the answers we've accumulated, we can help you avoid similar situations. For this help, contact your Worthington distributor listed in the yellow pages. Or write Worthington Corporation, Section 20-22, Harrison, N. J.

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- Porous Metal Cylinder serves as a flame arrester and permits breathing of fixture
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- Cast Aluminum Guard has six sturdy braces for fixture protection
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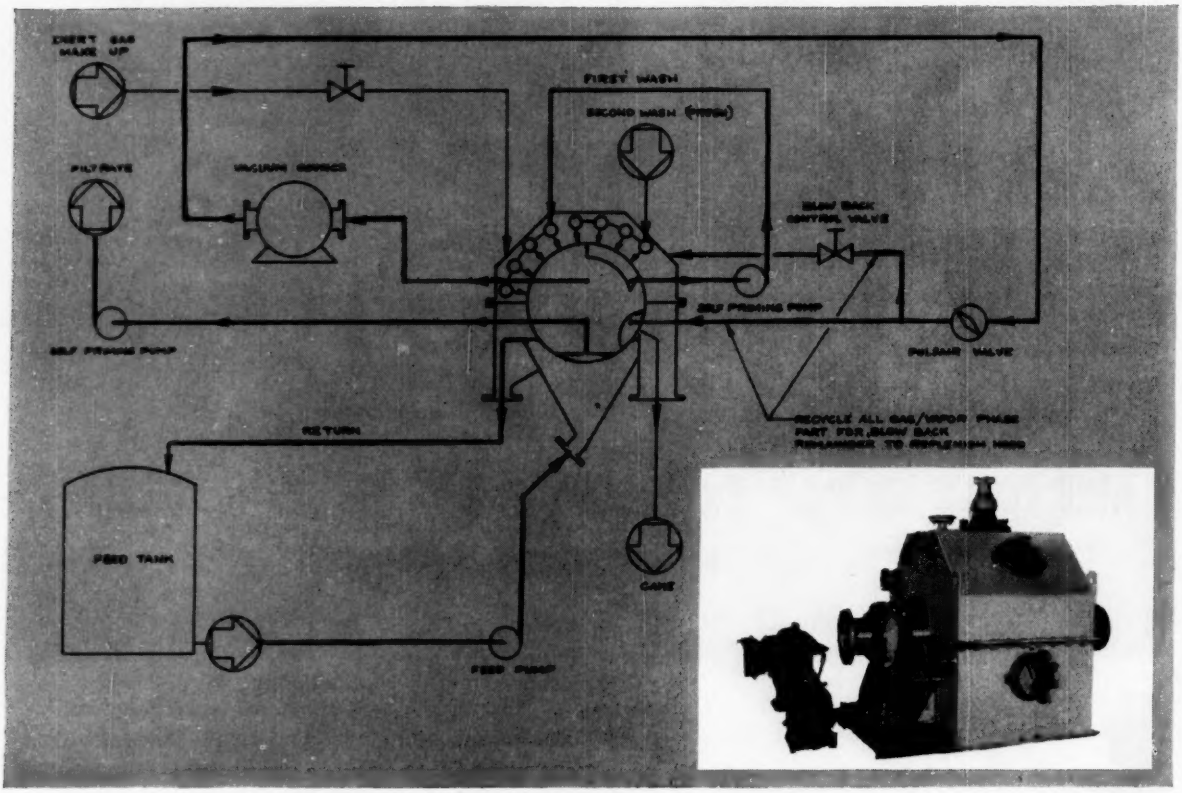
One Look at this Flow Sheet Tells You That the BIRD-YOUNG Vacuum Filter Is the One for Fume-Tight Operation



The Bird-Young Filter's unique design and simplicity of construction readily permit totally enclosed, tightly sealed operation. Exhausted air or vapor is subject to return so that pressure is always balanced and loss or expensive recovery of volatile solvents is avoided.

Before you buy a vacuum filter, look into the Bird-Young. The Bird Research and Development Center is well equipped to give you a look at actual performance facts and figures in advance of your investment.

Other advantages of Bird-Young design include:

- **high throughput of solids per foot of filter area** which often means fewer or smaller units
- **sharp separation of wash liquors from the filtrate and from each other** — efficient thin cake operation permits unlimited wash volume if need be
- **ability to handle big volumes of filtrate** since flow is completely unrestricted — no internal piping

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Chemical Engineering

March 20, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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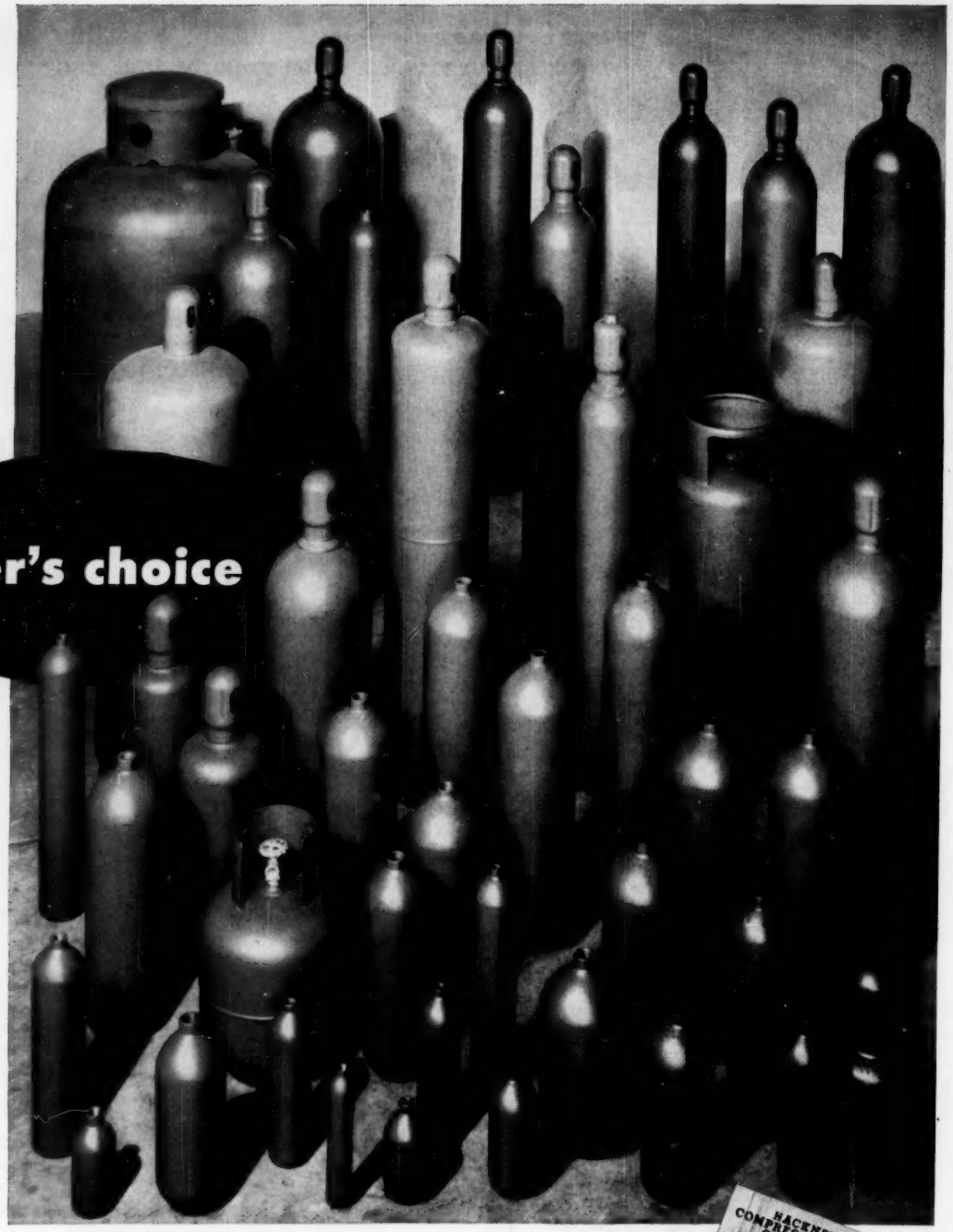

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CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

Chemical Engineering
MARCH 20, 1961

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highlights of this issue

EVALUATE HEAT EXCHANGER COEFFICIENTS

How dirty are your heat exchangers? Sometimes you don't really know until you find they won't handle peak loads. Monsanto's J. F. Frantz outlines a method (p. 151) that permits you to keep close tabs on fouling conditions despite variations in flow rates that affect measured coefficients. You'll thus know in advance when exchangers need cleaning.

NEW PROCESSES ADD FLAVOR TO CAPROLACTAM STEW

Three different starting materials figure in the growing competition among producers of caprolactam, the nylon-6 monomer. Cyclohexane and phenol are now being used commercially, but toluene will soon be in the picture. Here's a rundown on today's shifting technology in this field (p. 92) by Assistant Editor Clem Labine.

FILTER AIDS SPEED DIFFICULT FILTRATIONS

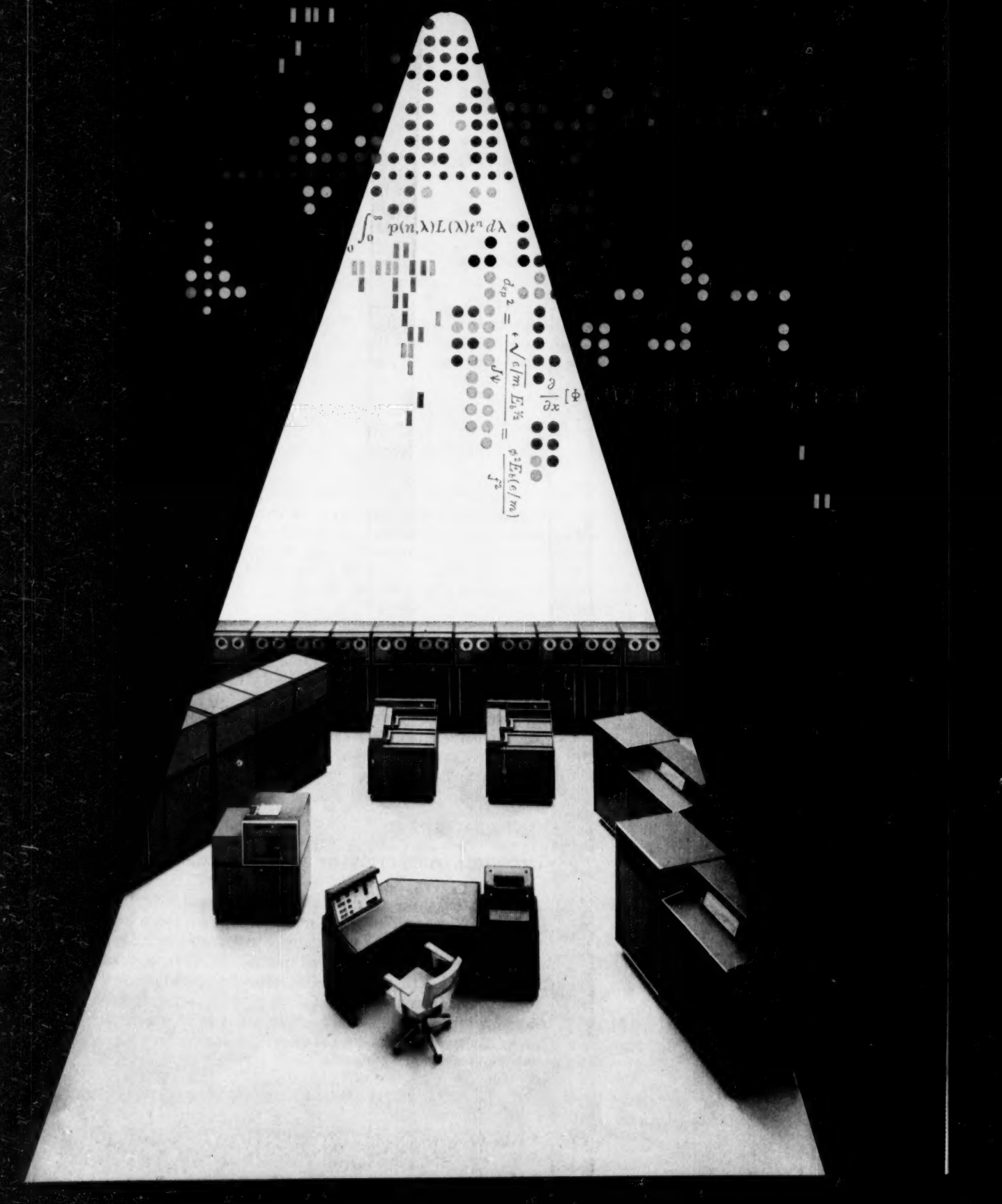
While the selection and use of filter aids is still pretty much a black art, there are certain basic facts and principles that every chemical engineer should know. Sharing 10 years of intensive filter-aid experience with *CE* readers in this article (p. 141) is Tom Jackson, product manager for Johns-Manville's Celite Division.

GRAPHICAL PREDICTION OF TERNARY AZEOTROPES

In distillation problems involving three components, formation of a ternary azeotrope may throw you for a loop—unless you are aware of its existence and allow for it accordingly. Here is a new, improved method (p. 159), developed by Paul Horvath of Goodrich Chemical, for predicting ternary azeotropes. You start with vapor-liquid equilibrium data for the three binary pairs, calculate van Laar constants and activity coefficients, wind up with a triangular graph of activity coefficient "isogams."

BURROUGHS CORPORATION ANNOUNCES

THE B 5000, WHICH SETS NEW STANDARDS



IN PROBLEM SOLVING & DATA PROCESSING

The new Burroughs B 5000 Information Processing System is a decided departure from conventional computer concepts. It is a problem-oriented system. Its markedly different logic and language are in large part dictated by the characteristics of ALGOL and COBOL. And it incorporates a complete set of operating, monitoring and service routines.

Additional operational features include an average add execution time of three microseconds, and a memory cycle time of six microseconds. Both character- and word-oriented, the B 5000 operates in binary *and* alphanumeric modes: a single set of arithmetic commands operates interchangeably on both fixed-point and floating-point numbers.

More important than these features is the fact that they combine with compiler-oriented logic and language to provide a new concept in computing—an integrated hardware-software system which sets:

NEW STANDARDS OF PROGRAMMING EFFICIENCY

Incorporating logic and language designed to take advantage of modern compiler techniques, the B 5000 permits straightforward, efficient translation of common-language source programs. And it brings a new high in compilation speeds—20 to 50 times faster than those possible on conventional computer systems.

NEW STANDARDS OF AUTOMATIC OPERATION

A Master Control Program, incorporating the automatic operating, monitoring and service routines, is pre-stored on a fast-access drum. It automatically schedules work according to pre-assigned priorities; allocates memory and input/output assignments; and maintains maximum-efficiency use of all components through a comprehensive interrupt system. As a result, human intervention is minimized, system efficiency maximized.

NEW STANDARDS OF PROGRAM-INDEPENDENT MODULARITY

Availability of multiple, functionally independent modules provides the B 5000 with excellent system flexibility and expansibility. The system may include one or two independent processors; up to eight core memory modules with a total capacity of 32,768 48-bit words; and one or two fast-access bulk storage drums, each with a capacity of 32,768 words. Up to four independent input/output channels control a maximum of 26 input/output units, including up to 16 standard-format magnetic tape units. Additional input/output units include card punch and reader, two types of printer, plotter and keyboard.

NEW STANDARDS OF EFFECTIVE MULTI- AND PARALLEL PROCESSING

The Program Independent Modularity of the B 5000, combined with the automatic scheduling and control features of the Master Control Program, permits multi-processing—the B 5000's normal mode of operation. The addition of a second functionally independent processor provides true parallel processing ability.

NEW STANDARDS OF SYSTEM COMMUNICATION

The new B 5000 permits simultaneous on-line/off-line operation. It features completely flexible communication among all of its units. A central processor communicates with all memory units. Any input/output channel communicates with any peripheral equipment and any memory module.

NEW STANDARDS OF THROUGH-PUT PER DOLLAR

All of these B 5000 features combine to provide an important new standard of through-put—the maximum amount of work in the shortest possible time, using the fewest possible components. The result is large-scale performance in the medium-price range.

For details in depth on the B 5000, call our nearby office. Or write for a copy of "The B 5000 Concept" to Data Processing Division, Burroughs Corporation, Detroit 32, Michigan.

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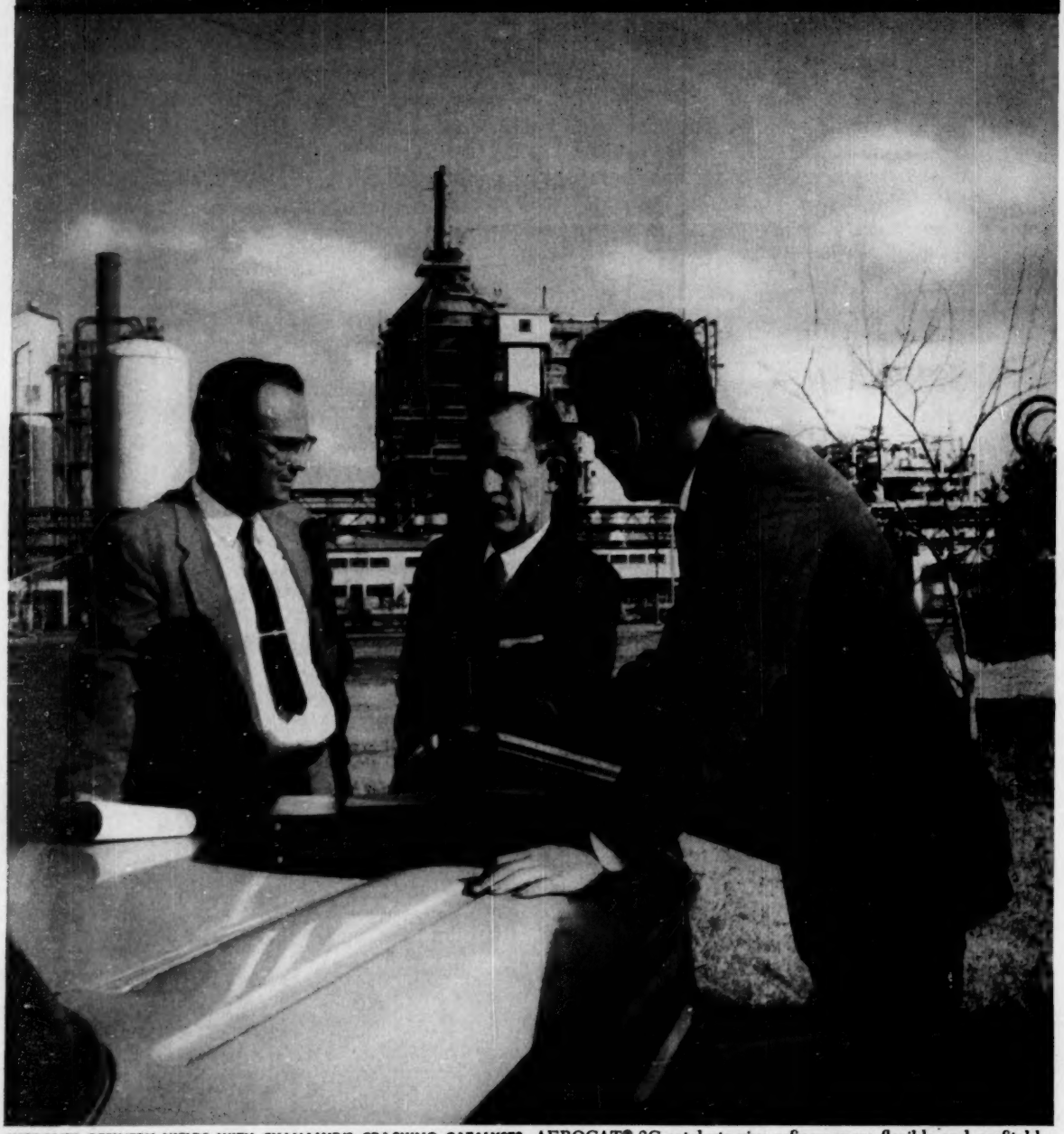
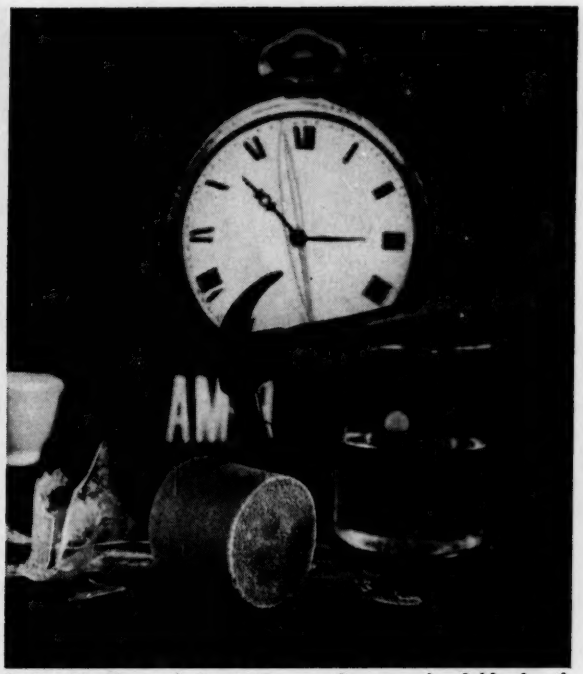
Chemical Newsfront

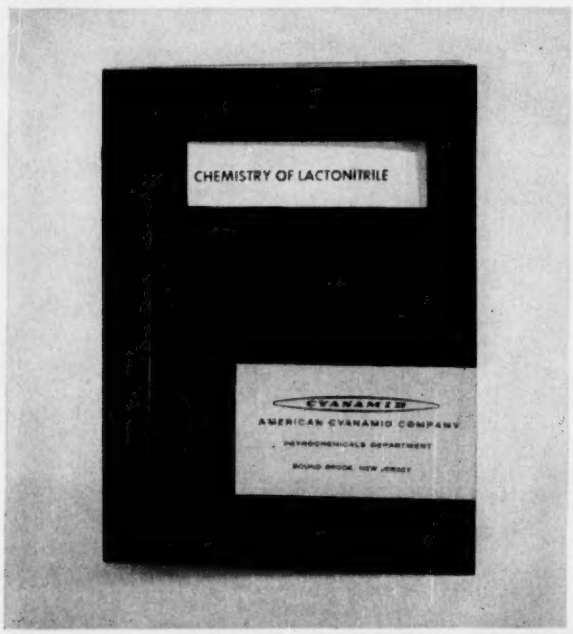


IMPROVED REFINERY YIELDS WITH CYANAMID'S CRACKING CATALYSTS. AEROCAT® 3C catalysts give refiners more flexible and profitable operations. These three component fluid cracking catalysts yield more gasoline, propylene, and butylene at the expense of dry gas and coke. Cyanamid representatives continually work with petroleum refiners to determine the suitability of AEROCAT 3C to their cat cracking operations. **(Refinery Chemicals Department)**

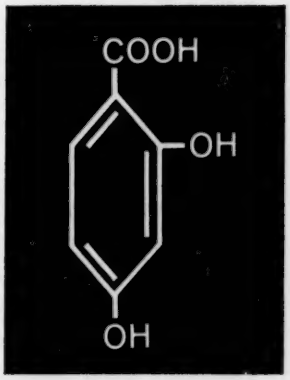


AMAZING NEW CHEMICAL CHANGES THE EARTH'S CONSISTENCY. With AM-9* Chemical Grout, Cyanamid enters the field of soil stabilization. Illustrated above, we see AM-9 transforming porous soil into impervious matter. The powdery chemical may be dissolved in water right at a construction site. Catalysts are added and the mixture is pumped into drilled holes. Result: Ground through which water cannot flow. **(Organic Chemicals Division)**

*TRADEMARK



LACTONITRILE — INEXPENSIVE, BIFUNCTIONAL RAW MATERIAL. This chemical is convertible to a host of useful intermediates. Among these are lactic acid, ethyl lactate and, in combination with other products, a filler for nitrile-containing plastic materials. For the full story, send for the above booklet checking the appropriate area on the coupon. **(Petrochemicals Department)**



FORMULA FOR A WIDE RANGE OF REACTIONS. Cyanamid's Beta Resorcylic Acid, a versatile starting material for the preparation of commercial organic compounds, is available from plant production. High purity, low color and low density, coupled with its reactivity, suggest uses where resorcinol or salicylic acid is now employed. **(Market Development Department)**

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The Honeywell Control Valve (foreground) regulates flow of Bunker C fuel oil burner in a chemical process drying system. In the background, a Honeywell diaphragm actuator operates a damper for control of hot air return. Nothing spectacular going on here, but the results of the entire process could well depend on these valves.

The final results—the payoff of the process—are dependent not just on how well these valves are made, not just on their capacity or sensitivity, but on *all* of these things combined . . . plus the process control knowledge that first put them to work, and the know-how that keeps them on the job.

Here, as in all Honeywell Control Valve applications, *every* aspect of valve performance has been considered in relation to the overall control system. It is this "whole picture" approach that sets Honeywell Control Valves apart, and rewards you with better processing.

Write today for your copy of our checklist, "25 Ways to Be Right" . . . in selecting control valves.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

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Honeywell

First in Control

NEW TOOLS FOR FORMULATING HEATING OILS

PARADYNE® HO-10 and PARADYNE® HO-20 POUR DEPRESSANTS

FOR THE REFINER

Greatly increased freedom to adjust operations and inventories to meet changes in demand. More kerosene available for jet fuel, diesel fuel or other high value outlets. More high pour components receiving heating oil instead of fuel oil value.

FOR THE MARKETER

An end to costly operating difficulties formerly unavoidable in cold weather. Unprecedented flexibility in utilizing available heating oil inventory in almost any weather.

EFFECTIVE AT LOW CONCENTRATIONS

Paradyne HO-10 and Paradyne HO-20, in concentrations of only 0.01 to 0.1 weight per cent can lower ASTM pour points of heating oils variously by 10 to more than 70 degrees Fahrenheit. Either one or both have been found effective in over 90 per cent of stocks tested.

HOW THEY WORK

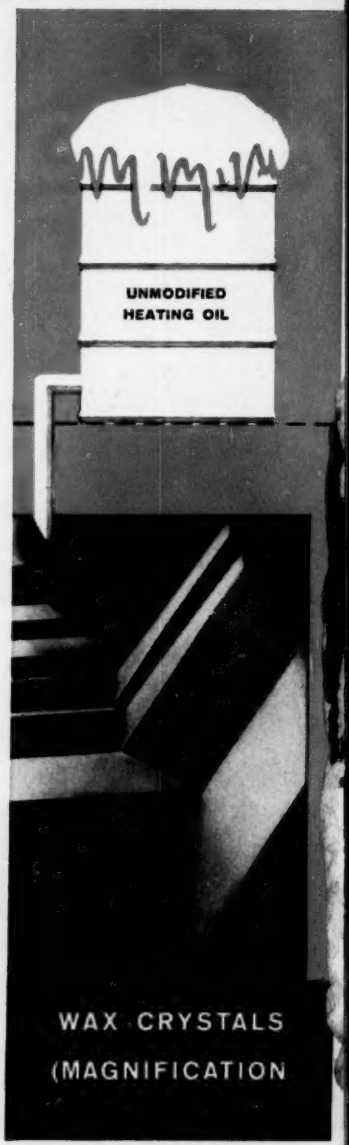
Paradyne HO-10 and Paradyne HO-20 – both designed specifically for use in heating oils – drastically modify the size and structure of wax crystals formed when heating oil is cooled below its cloud or pour point. The pictures in the centerfold demonstrate their effect.

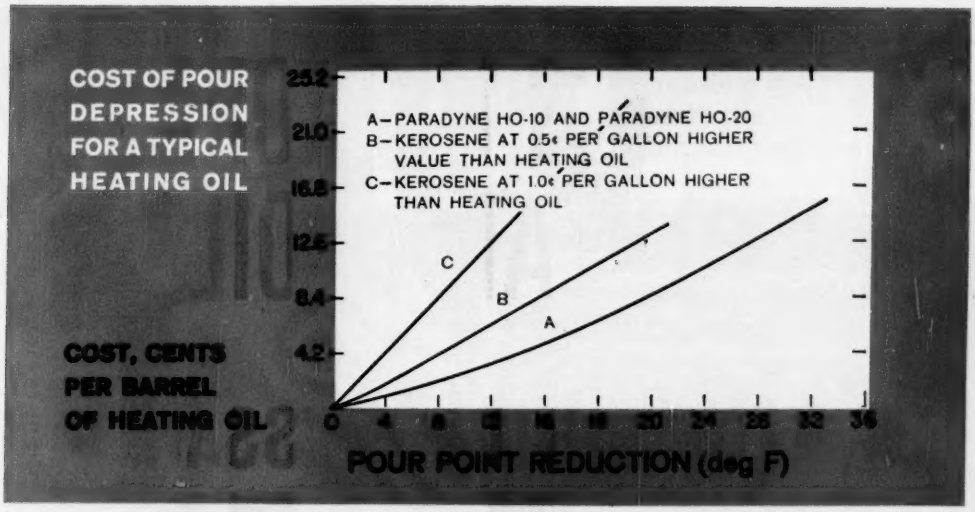
WINTER FIELD TESTS REVEAL OUTSTANDING EVIDENCE...

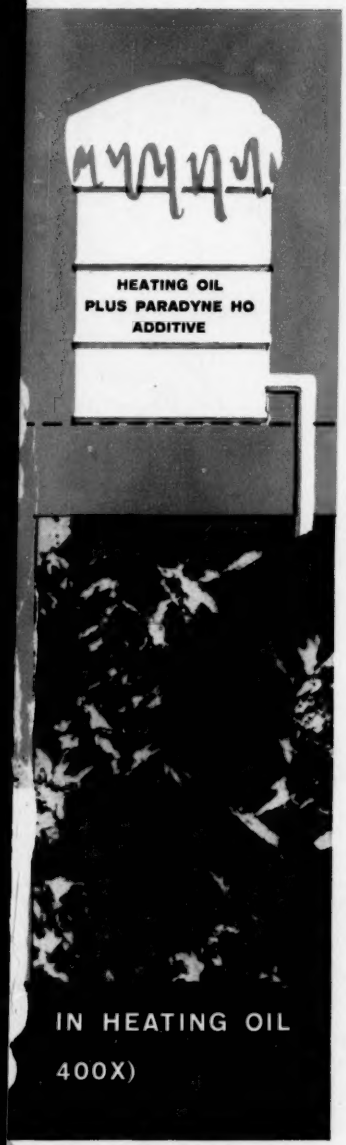
In addition to extensive laboratory tests, a wide range of field tests have been carried out in Canada and Maine during severe winter climate.

Two heating oils having natural pour points of 20°F and –5° were both depressed with Paradyne HO-20 to –45°F and –40°F. The fuels were evaluated for low temperature flow properties in 12,000-gallon storage tanks, in tank truck deliveries, and in 524 home heating units.

Even though the ambient temperature reached –30°F, good operability was obtained in storage, delivery and customer units.







AND HERE'S HOW THESE ENJAY ADDITIVES STACK UP IN COST AGAINST KEROSENE...

The cost of lowering the pour point of a typical heating oil with Paradyne HO-10 or Paradyne HO-20, compared with kerosene may be seen here at a glance.

BLENDING FLEXIBILITY

Paradyne HO-10 and Paradyne HO-20 may be added to heating oil at any point in the distribution system—at the refinery, bulk plant or at the local terminal.

EASY EVALUATION OF EFFECTIVENESS

It's easy to determine which and how much new Paradyne HO additive to use by simple ASTM pour determinations:

1. Test the response of heating oils to both additives.

2. Evaluate heating oil responses over a range of additive concentrations.

3. Vary proportions of various stocks to be blended in the finished fuel. Generally, to effect maximum savings, evaluate the effect of high-pour components on blends.

COMPOSITION AND APPEARANCE

Both Paradyne HO-10 and Paradyne HO-20 are approximately 50% concentrates of active ingredient in kerosene. Both are liquids at room temperature.

EASY TO STORE AND HANDLE!

For further information write to 15 West 51st Street, New York 19, New York.

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A DIVISION OF HUMBLE OIL & REFINING COMPANY

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LINK-BELT conveyors

The last word in value from the first name in conveyors

BELT CONVEYORS — Link-Belt serves as a single source for design, equipment and erection of *Job-Engineered* belt conveyors for small or large tonnages, for routes of any length. Link-Belt engineers have the selection advantage of industry's most comprehensive idler line—plus a broad range of pulleys, drives, terminal machinery and auxiliary equipment. Husky, *Pre-Bilt* sectional belt conveyors are also available.

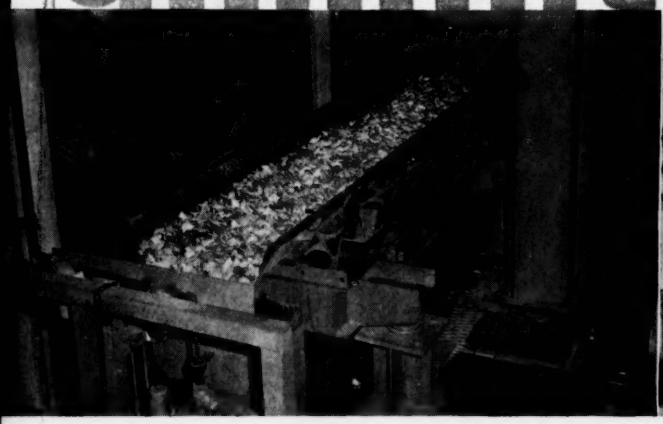
"Conveyors unlimited" means just that! Link-Belt offers *industry's most complete line of conveyors* . . . all built to quality standards that are second to none in the field of materials handling. And because Link-Belt makes such a wide variety of types and sizes, you can be sure of unbiased recommendations . . . can count on the operating economies and efficiencies that only perfectly job-matched equipment provides.

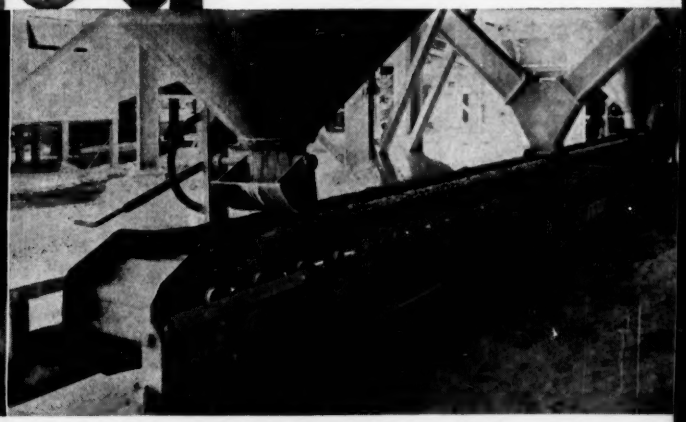
Also important, Link-Belt can provide *complete* handling systems . . . patterned exactly to your requirements with a background of more than 80 years of conveyor specialization. Our engineers are familiar with the particular handling needs of every industry. It's more than likely they have met—and solved—many problems similar to yours. We will design, equip and erect your entire installation . . . and accept full responsibility for its successful operation.

For full information—on single components or complete systems—large or small—contact your nearest Link-Belt office. Catalogs covering all conveyors are available on request.

unlimited

The line that means savings, whether handling raw materials or finished products



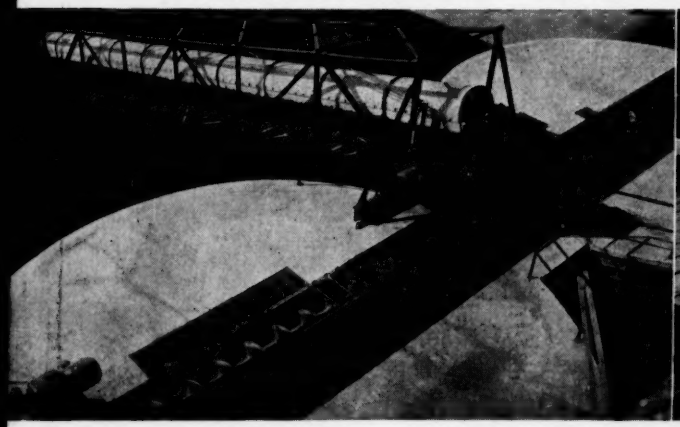


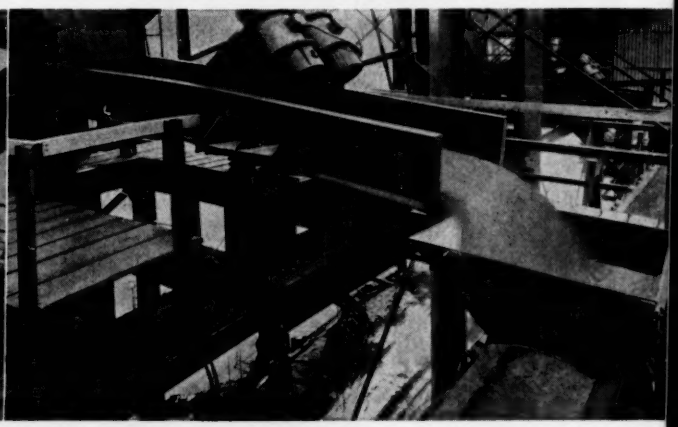
OSCILLATING CONVEYORS — Whether handling fines, granules or chunks, Link-Belt's four types of oscillating conveyors—Flexmount, Coilmount, Heavy-Duty Coilmount or Torqmount—provide surge-free movement of materials. All types feature *full-time positive action*, yet operate as near to *natural frequency* as possible to minimize power requirements.

APRON CONVEYORS — Wide application range provides efficient handling of a variety of materials. Materials are moved with a minimum of degradation over horizontal or inclined paths, or a combination of both. Jointed, overlapping or interlocking apron pans form the continuous carrying surface. Drawing from a variety of available chains coordinated with pan design, Link-Belt can match the conveyor to your particular needs.

SCREW CONVEYORS — Easily adapted to congested locations . . . operate horizontally, vertically or inclined. Link-Belt provides all components for a complete screw conveyor line. Exclusive optional *Quik-Link* feature permits fast, easy removal of any conveyor section without disturbing other components.

FEEDERS — Types for any capacity, any material. Link-Belt produces industry's broadest feeder line . . . belt, apron, reciprocating, screw, vibratory, bar, gravimetric and rotary types provide a uniform, controlled feed either mechanically, electrically or by weight.





LINK-BELT

CONVEYING AND ELEVATING EQUIPMENT

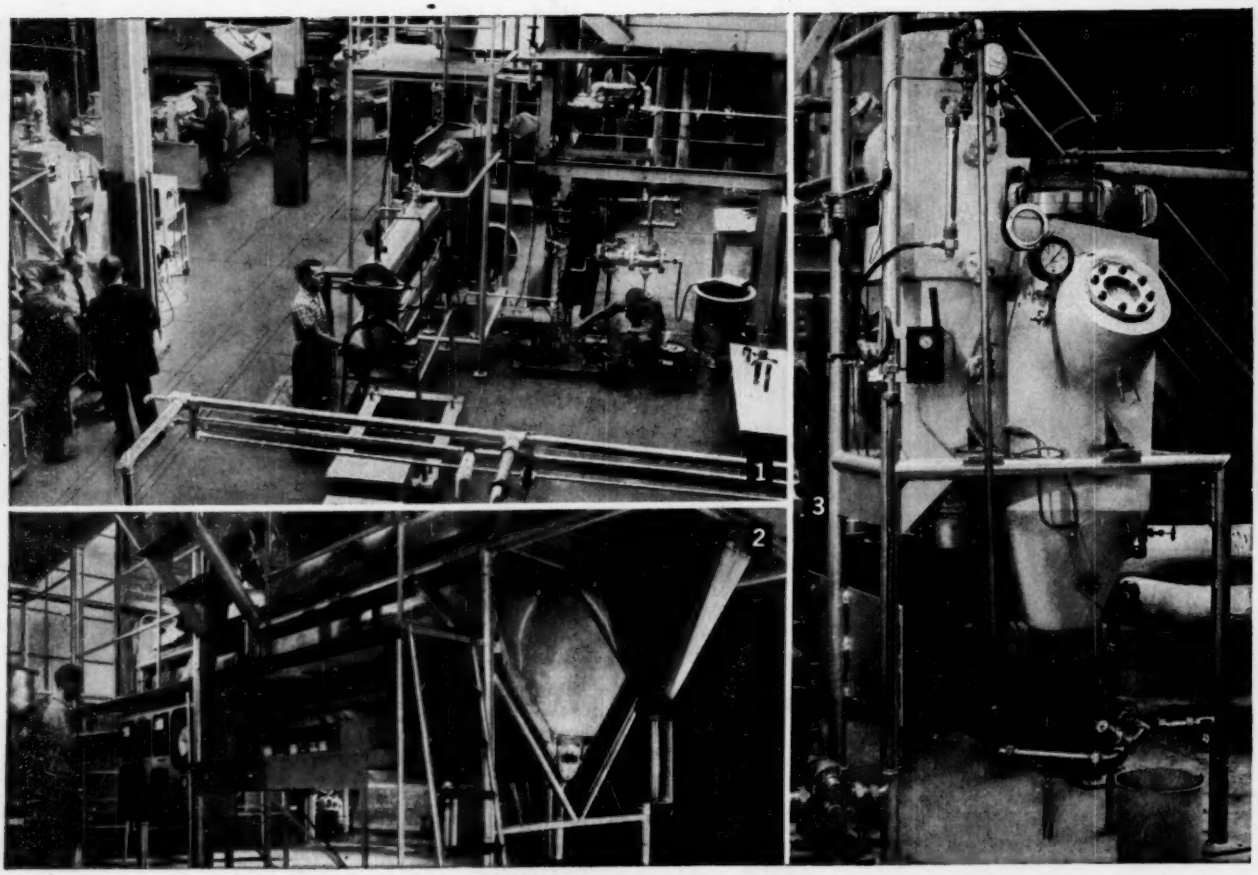
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses and District Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.

15,617

Keeping production on the move in every industry

Apron conveyors
Arm and tray elevators
Belt conveyors
Bucket elevators
Bucket elevators-conveyors
Bulk-Flo
Car-type conveyors
Chain conveyors
Circular carrier conveyors
Drag conveyors
Flight conveyors
Flite-Flo conveyors
Oscillating conveyors
Power-and-free conveyors
Pusher chain conveyors
Scraper conveyors
Screw conveyors
Sidekar-Karrier conveyors
Skip hoists
Slat conveyors
Trolley conveyors
Trukveyors

Key chemical processors come to Buflovak to develop new and better products at lower cost

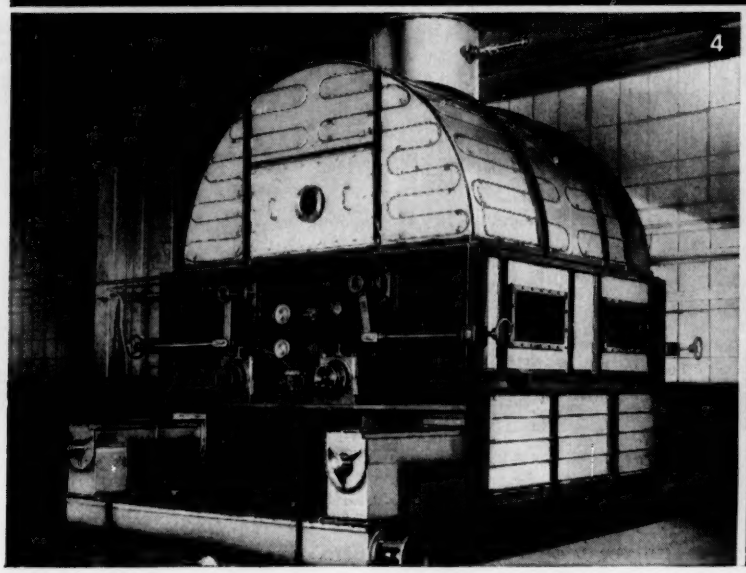


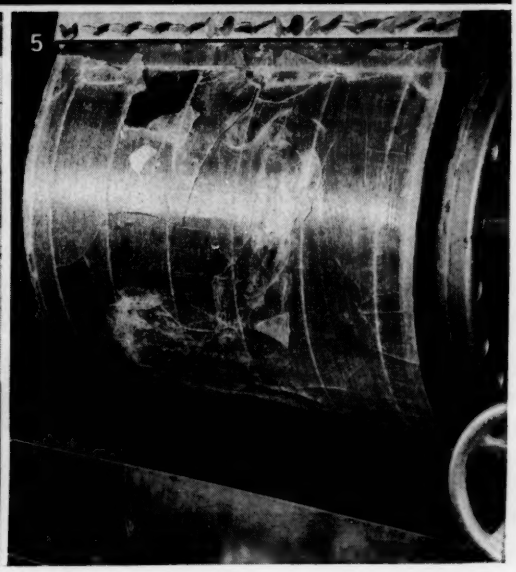
More and more of today's progressive chemical producers explore new products and processes with Buflovak's experienced engineers. **Research** often starts in the Buflovak Customer Technical Service Laboratory—a completely equipped research center for investigating evaporation, drying, solvent recovery, cooling, and other processes. Here you can test by the beakerful or run carload lots on a round-the-clock production scale. **Engineering** experts work with test results or your known specifications . . . impartially select the right units from Buflovak's complete line of processing equipment. Whenever custom units are preferable, they use their design know-how and production facilities to follow through. **Service** from Buflovak includes realistic deliveries and continuing customer service to keep your operation humming, your profits climbing. Write for Catalog 392 or see our insert in Chemical Engineering Catalog. Buflovak Equipment Division, 1551 Fillmore Avenue, Buffalo 11, New York.

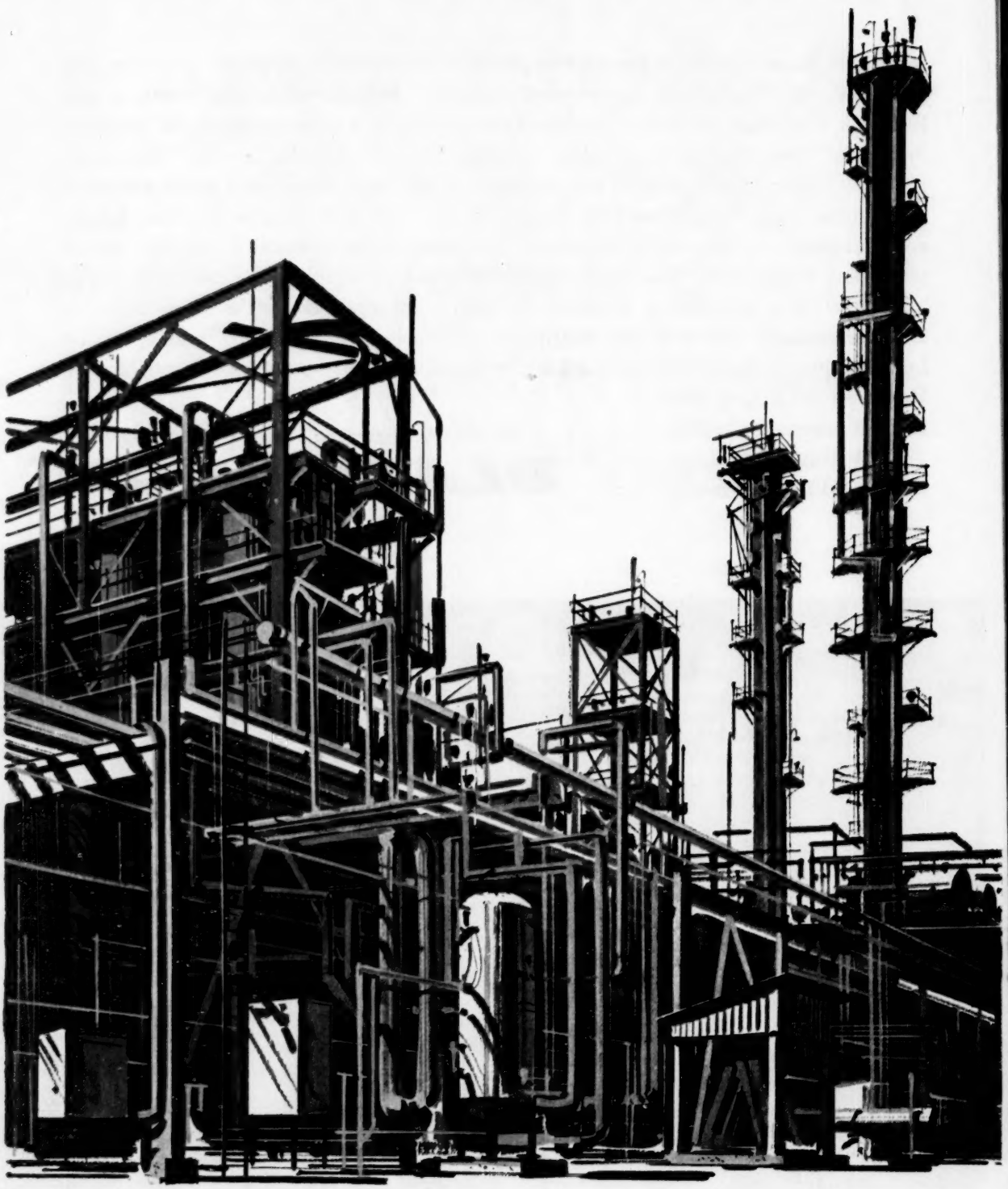
Buflovak Equipment Division

BLAW-KNOX

1 Customer Technical Service Laboratory has solved over 8000 processing problems. Here you can test new products, examine process efficiency, explore by-product possibilities for extra profits. **2 High Velocity Spray Dryer** converts liquid to a dry product instantaneously. Short exposure to heat retains desirable product characteristics. Also used for efficient cooling. **3 New Agitated Film Roto-Vak** provides high heat transfer and a processing time of only seconds . . . now permits concentration of viscous, foamy, salting and extremely heat-sensitive products never before successfully concentrated. **4 Atmospheric Double Drum Dryer** is fully enclosed to provide positive protection from dust hazards, and to allow the dried product to be removed continuously. **5 Flaker with grooved drum** handles molten materials ordinarily repelled by smooth drum surfaces. Buflovak flakers available in open types or with enclosures.







Foster Wheeler *Heat Engineered* products, plants and processes... for the world's industrial progress.

Chemical plant or petroleum refinery?

It takes some, but not a lot of experience, to know at a glance what kind of plant this is. It takes a good deal more to design and build one. And to consistently build profitable process plants demands even greater experience.

Experience in depth means going "on stream" smoothly . . . without long unprofitable start-up. It means long runs that are *designed in* and dependability that is *built in* . . . with low maintenance and truly economic performance.

As your engineering-contractor, Foster Wheeler puts the full measure of 40 years' experience to work for you in the design, engineering or construction of your plant.

Consult with FW's engineering staff when you consider expansion of facilities, plant modernization, or an entirely new installation such as the petro-chemical plant illustrated here. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

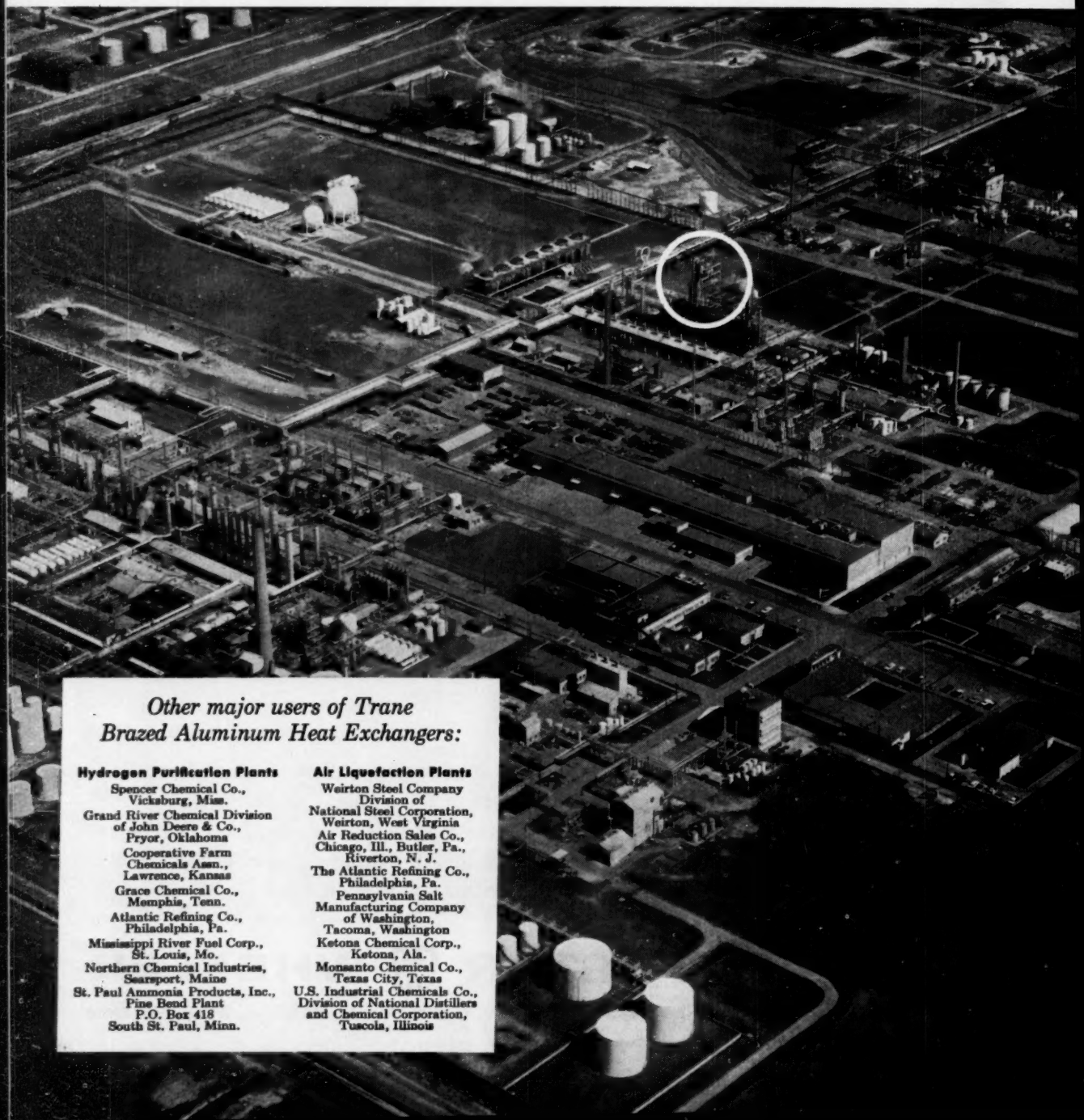
FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

Shell Chemical Corporation reports:

Lower structural, installation Trane Brazed Aluminum

Air view of Shell Chemical Corporation's Houston, Texas, plant. Lightweight and compact construction of TRANE Brazed Aluminum Heat Exchangers made it possible to install condensing unit on top of a 140-foot tower—cutting construction costs.



Other major users of Trane Brazed Aluminum Heat Exchangers:

Hydrogen Purification Plants

Spencer Chemical Co., Vicksburg, Miss.
Grand River Chemical Division of John Deere & Co., Pryor, Oklahoma
Cooperative Farm Chemicals Assn., Lawrence, Kansas
Grace Chemical Co., Memphis, Tenn.
Atlantic Refining Co., Philadelphia, Pa.
Mississippi River Fuel Corp., St. Louis, Mo.
Northern Chemical Industries, Searsport, Maine
St. Paul Ammonia Products, Inc., Pine Bend Plant P.O. Box 418 South St. Paul, Minn.

Air Liquefaction Plants

Weirton Steel Company Division of National Steel Corporation, Weirton, West Virginia
Air Reduction Sales Co., Chicago, Ill., Butler, Pa., Riverton, N. J.
The Atlantic Refining Co., Philadelphia, Pa.
Pennsylvania Salt Manufacturing Company of Washington, Tacoma, Washington
Ketona Chemical Corp., Ketona, Ala.
Monsanto Chemical Co., Texas City, Texas
U.S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation, Tuscola, Illinois

and piping costs with Heat Exchangers!

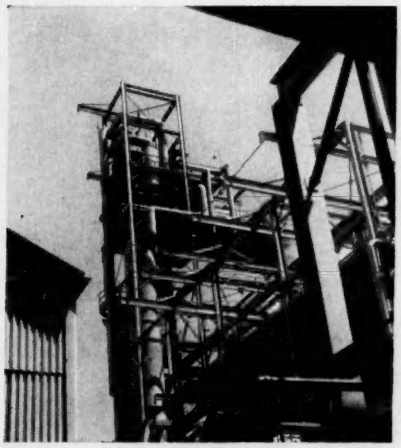
Lightweight aluminum surface made it possible to install heat exchanger on top of 140-foot tower

This Shell Chemical Corporation plant near Houston, Texas, has used TRANE Heat Exchange equipment for over two years in the production of ethylene. And, Shell reports, the TRANE Heat Exchanger is functioning exactly as specified . . . operating at temperatures down to -185° F, with extremely close temperature approaches.

An outstanding feature of the installation is the location of the unit: it was erected on top of a 140-foot tower to reduce piping costs and to meet thermodynamic specifications. This type of installation was possible because of the very lightweight and compact construction of the TRANE Heat Exchanger. And it resulted in lower installation costs, savings in valuable ground space. Shell is achieving lower operating costs, too, because of lower heat losses and extremely close temperature approaches.

This light and compact—yet rugged—heat exchange surface is being used in more and more installations where superior performance is essential. And TRANE Brazed Aluminum Heat Exchangers reduce erection and space costs, too, because a typical TRANE unit requires only *half as much space* as conventional heat transfer equipment!

If you're interested in reduced refrigeration costs, close temperature approaches, trouble-free operation, design with TRANE Brazed Aluminum Heat Exchangers. Thirty years of specialized heat transfer experience is at your service! Ask your nearby TRANE Sales Office for complete information. Or write TRANE, La Crosse, Wisconsin.



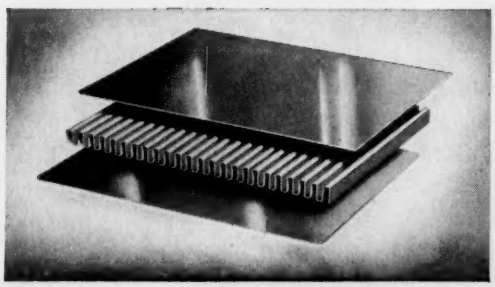
3-stream exchanger condenses a hydrocarbon gas mixture by refrigeration from two colder gases. Operating temperatures are as low as -185° F. Design pressure is *545 psig.*

For any air condition, turn to

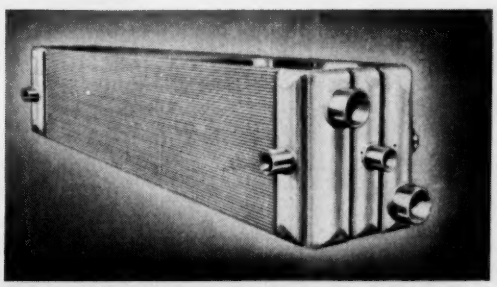
TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U.S. AND 19 CANADIAN OFFICES



Lightweight, compact, rugged! TRANE Brazed Aluminum surface consists of corrugated aluminum sheets brazed together to form a stack of layers that provide individual passages for the flow of gases or liquids. Provides up to *nine times* the surface per square foot of shell-and-tube exchangers!



Headered for 5-stream operation, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of specifications.

CORROSION meets its match in Alcoa aluminum conduit

Here's an electrical rigid conduit that you can install and forget.

Alcoa aluminum conduit solves most corrosion problems in and around chemical plants.

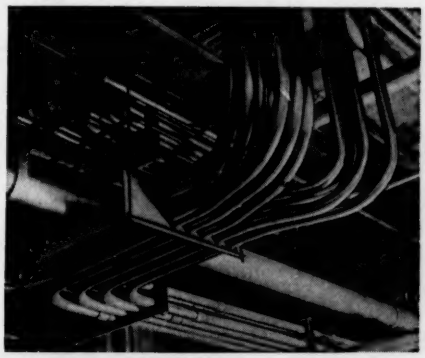
Aluminum protects itself Unlike other conduits, which require some kind of coating, aluminum forms its own protective film. This film forms naturally in the atmosphere and in the presence of oxidizing agents. Damaged spots are self-repairing—almost instantly! The natural oxide coating on aluminum takes the place of factory coatings on conventional conduits and only under unusual conditions is any other protection required.

Other advantages Corrosion resistance is just one good reason for selecting aluminum conduit. Its light weight (about ⅓ as much as steel) makes it easier to handle and install. Alcoa aluminum conduit is also nonmagnetic and non-sparking.

How about cost? Consider initial cost, savings in installation and maintenance, and service life. You'll see that Alcoa aluminum electrical rigid conduit stacks up as a sound investment.

More information For specifications, or answers to specific questions about the use of aluminum conduit in corrosive environments, contact one of our nearby representatives. Or write to Rome Cable Division of Alcoa, Dept. 22-31, Rome, New York.

ROME CABLE
DIVISION OF **ALCOA**



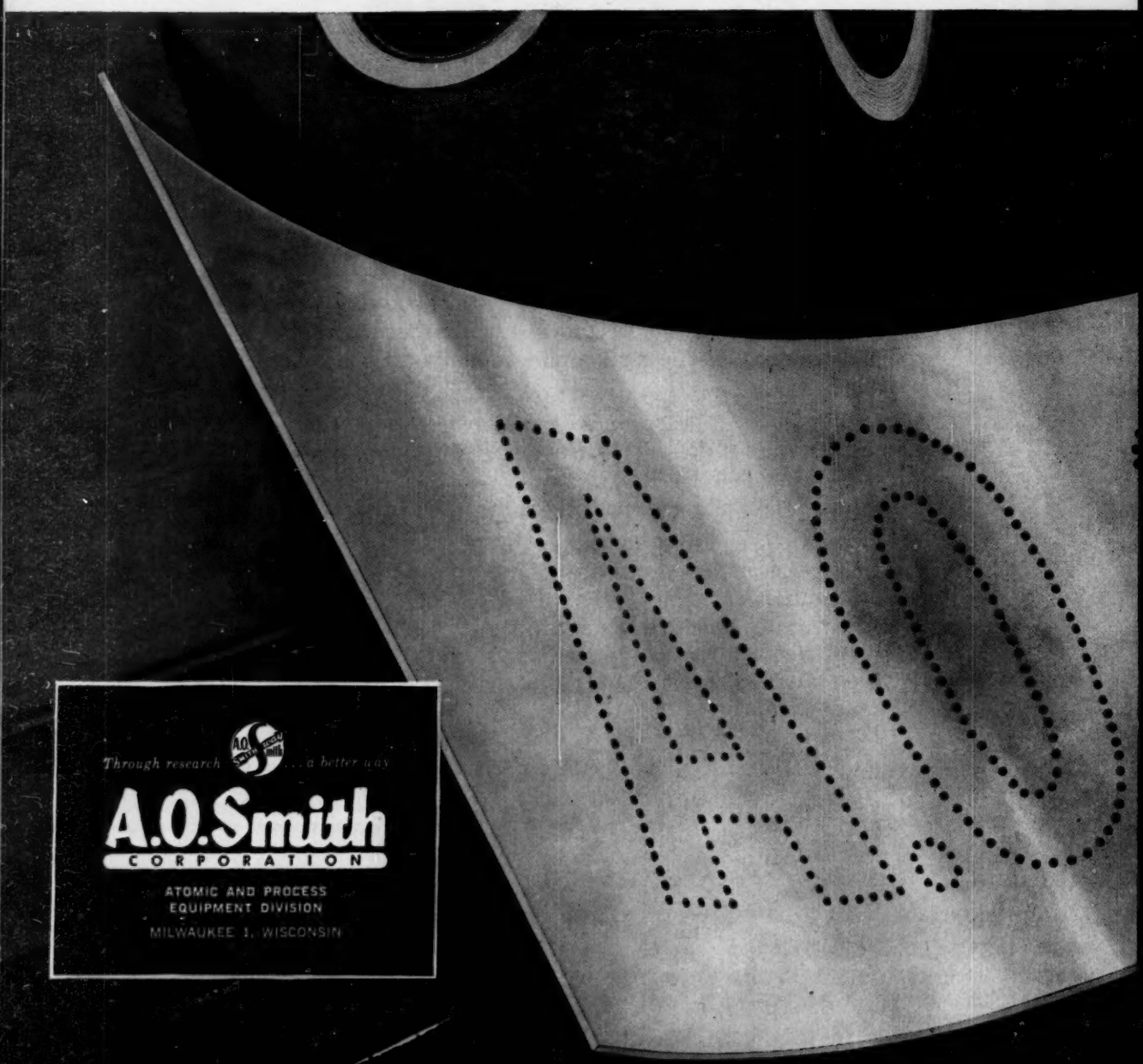
NO CORROSION despite moisture, chemicals and vapors in the basement of this sewage disposal plant in Cleveland. Installed in 1932, this Alcoa conduit still looks almost like new.

big name in vessel reliability

because A. O. Smith has the big resources to combat corrosion and pressure problems

A big name for your big problems — A. O. Smith has the facilities and capabilities to build *any* type and size pressure vessel or heat exchanger for *any* chemical process. You draw upon a reservoir of experience that goes back over 35 years . . . looks forward to new challenges.

So you come up with the process and leave the stress and corrosion problems to us. An experienced staff of research scientists will help you analyze your process conditions — make recommendations as to the design, material and fabrication best suited to your needs. Master workshops housing



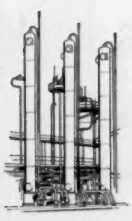
Through research A.O. SMITH ... *a better way*

A.O.Smith
CORPORATION

ATOMIC AND PROCESS
EQUIPMENT DIVISION
MILWAUKEE 1, WISCONSIN

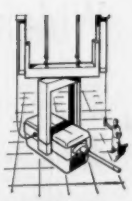
every advance known to modern technology give form and purpose to steel. And from raw materials to installation, vessel production is governed by the strictest standards of *reliability* — constant testing that assures safety and dependability. Contact your nearest A. O. Smith office and put these resources to work for you.

WANT TO KNOW MORE ABOUT US? Then write for new brochure titled, "From Arc to Atom." It tells about the Atomic and Process Equipment Division of A. O. Smith — the full story on our facilities and capabilities.

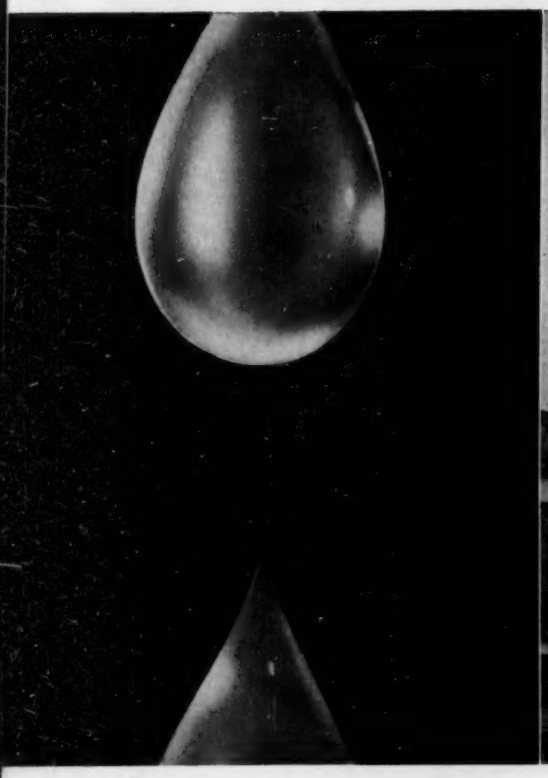


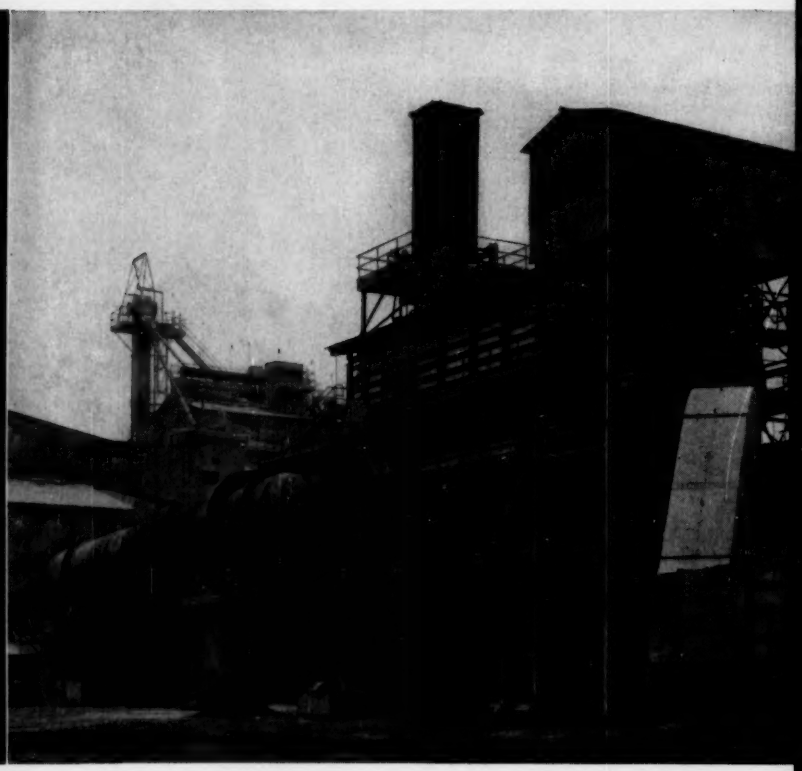
EVERYTHING IN VESSELS — Reactors . . . heat exchangers . . . autoclaves . . . fractionating columns . . . tanks . . . in stainless steel, carbon steel or glass-lined. You name it! A. O. Smith can build it. Tremendous construction flexibility assures a vessel that will fit your process. An important point: You never have to adapt your process to fit A. O. Smith chemical processing equipment.

QUALITY CONTROL — A. O. Smith's high standards for product excellence are a direct result of its "all-seeing" test program. This summer an 8-million-volt linear accelerator will be installed at the Milwaukee plant. It will permit faster, more thorough radiographic inspection of welds in heavy pressure vessels.



ideas and news:





Nothing leaks in... or out of Electri-Cand pumps: Built without packing, stuffing box or seals, the pump-motor unit is completely fluid tight. Safely handles a wide variety of corrosive, toxic, and precious fluids without danger of contamination or loss. Liquid being pumped cools the motor, lubricates the bearings. Maintenance costs are low.

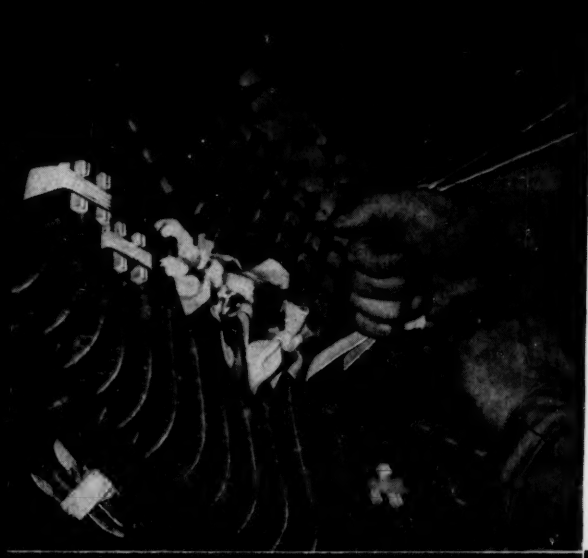
More high quality lime — less fuel: The Grate-Kiln System produces consistent high quality lime using 15% less fuel per ton of product than a conventional rotary kiln. Grate-Kiln Systems increase lime yield from limestone feed—outproduce conventional rotary kilns of the same overall length by 50%. Incorporated is a new high efficiency cooler which transfers maximum recuperated heat to secondary combustion air for kiln and preheater grate.

Which of these productive ideas could be working for you?

A control unit that saves space. A pump that pumps practically any solution. These examples demonstrate the extra value that is a standard with A-C... the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industrial Equipment Division, 907 South 70th Street, Milwaukee 1, Wisconsin.

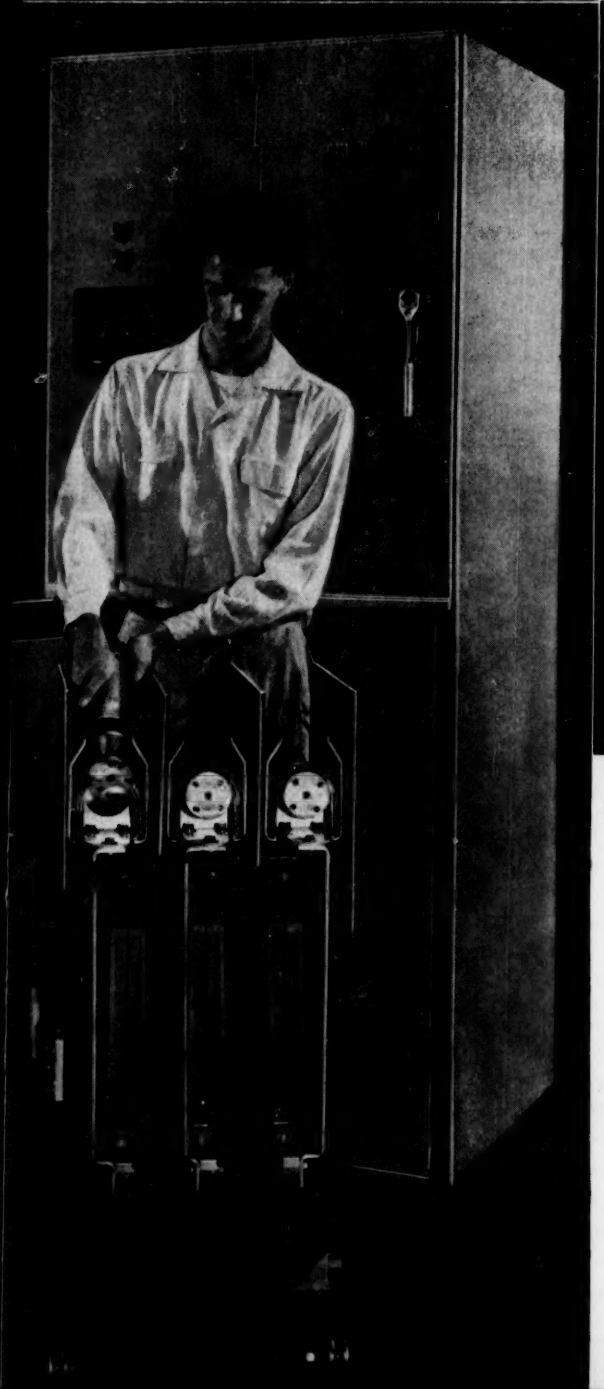
A-1404

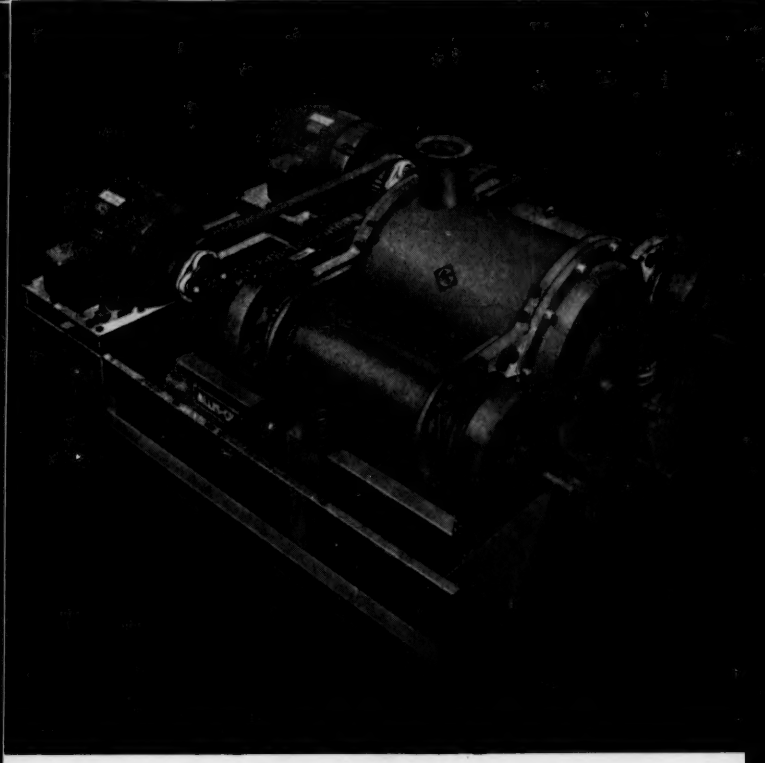
Electri-Cand, Shelter-Clad, SpaceMaker, Pyro-Shield, Silco-Flex, Grate-Kiln and Compactor are Allis-Chalmers trademarks.



New coil insulation means fast service: Here's downtime insurance you may never need. The Silco-Flex insulation system on large Allis-Chalmers motors is so superior that coil failure is highly unlikely in ordinary service. Should failure occur, the usual 10-day rewind shouldn't be necessary. Usually eight hours is enough for the entire job of replacing the coil.

Compact, 30-inch vibrating mill: Can actually outproduce a conventional tumbling mill 15 to 30 times per unit volume . . . is powered by just two 50-hp motors. Grinding media occupy 80% of mill's 12-cu.-ft. capacity, grind wet or dry materials as fine as two microns, as coarse as 48 mesh. Adaptable to grinding in inert atmosphere, can be utilized for closed or open-circuit grinding.





So low, two fit where one used to go: This new SpaceMaker control center is the first completely new 2- to 5-kv motor controller development in more than a decade. Two-high design can cut floor space needs in half. Full drawout construction makes it the safest, most easily accessible controller available. Flame-retardent, track-resistant Super Pyro-Shield insulation adds reliability. Walk-in Shelter-Clad enclosures available for outdoors.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, control, rectifiers, pumps, compressors, crushers, grinding mills, screens, kilns, coolers, dryers, Compactor mills, industrial systems.

OTHER A-C PRODUCTS: thermal, hydro and atomic electrical generating equipment, switchgear, transformers, unit substations, tractors, earth-moving equipment, engines, lift trucks.

ALLIS-CHALMERS

FISCHER & PORTER

ONLY COMPLETE FLOWMETER HOUSE

THE HANDIEST GUIDE TO THE VARIOUS AND SUNDRY METHODS PRESENTLY AVAILABLE FOR MEASURING FLOW

It has been our pleasure and profit over the years to aid and assist divers engineers in the estimable task of selecting the one—nay, the *only* device best suited to measuring a given flow. But truly, the years have added, the devices have multiplied, and the task of selection has grown ever more complex. As a result, the "handy" guides, so reminiscent of an earlier day have grown less handy all the time. Let us see how handy we can be.

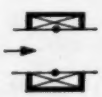
LESSON I

There are but four major types of flowmeters.

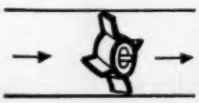
1. VARIABLE-AREA

2. VARIABLE HEAD

3. OBSTRUCTIONLESS



4. INTEGRATING



LESSON II

In order to be as handy as possible, we shall limit our discussion of the advantages of the four basic types to a single characteristic benefit.

1. Variable-Area: linear scale
2. Variable Head: flexibility
3. Obstructionless: obstructionless
4. Integrating: accuracy

LESSON III

This lesson is of the most importance as it concerns the various factors necessarily involved in the judicious selection of flowmetering devices. These primary and critical factors are: fluid property limitations, application, installation and economics. We need not go into detail on these factors since our Bulletin 91-119, a veritable gem of condensation, reviews all of these factors in the short space of only six pages. There is a limit as to how short and "handy" such a guide can be.

If you are one of those, and there are many, who philosophically opposes all "handy" guides, then we need only remind you that we make all of the four major types. Indeed, we are the only company to do so. We also wish to state that we use a wide variety of materials to construct these meters including many readout and process control devices. Our laboratories include the finest and most advanced flow measuring and calibrating equipment. A call to our field engineers can save you trouble and bring you a firm recommendation unencumbered by bias or prejudice.

TO THE RIGHT

is a sampling of some outstanding examples of each type of meter in our flowmetering line.

{ Variable-Area Flowmeters }

Fischer & Porter has indeed made its mark in lands far and wide as the leading manufactory of variable area meters, finding itself pleasantly faced with such wide acclaim for ease of use and simplicity that it defies description. Yea, and to no surprise. Indeed our people have labored unceasingly to INTRODUCE EVERY MAJOR ADVANCE in this noble form of flowmetering, to wit: the glass tube that allows viewing the rate of flow directly; the bead-guide and Tri-Flat meter for matchless float stability; the predictable float which simplifies calculations; the metal tube for high pressures and temperatures.

Frictionless! Foolproof!

—herald the fortunate employers of the MAGNABOND coupling developed by Fischer & Porter for detecting the linear motion of the float, with abundant power to operate a multitude of accessories for recording, transmitting, totalizing and controlling. The ingenious detection system employs permanent magnets sealed into a non-magnetic, corrosion-resistant extension unit, and is widely used in conjunction with the popular FLOW-RATOR meters.

The NEW, ALL NEW

MAGNARATOR

with

FLOW INDICATOR

and

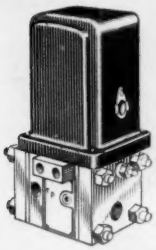
PNEUMATIC TRANSMISSION

This amazing apparatus is distinguished as the TRUE in-line, through-flow meter. Of great joy to installation and maintenance men alike, no extension is needed and there are no

crooks, crannies or corners where material can collect. The MAGNARATOR, kin to the extension-type MAGNABOND flow transmitter, is lofted to great heights of applicability by a new magnetic coupling principle. It measures, indicates and transmits pneumatically with a linear output signal!

Variable Head Flowmeters

...featuring the



DP TRANSMITTER

by the wizards of Warminster

FISCHER & PORTER

Outwits PULSATION!
Outwits CORROSIVE FLUIDS!
Outwits STEAM TRACING PROBLEMS!

This popular differential pressure transmitter undeniably supports its claim as being the best in the world. Since it was first presented to the metering public its success has been remarkable. WHY? Its superiority over all others is substantiated by the FACTS OF ACTUAL USE!

ASTOUNDING ADVANTAGES
found in no like instrument

ADJUSTABLE DAMPING in the differential sensing system, Gentlemen, which is where it should be. We warrant there to be no other method that lets you measure PULSATING flow without zero shift, PHANTOM signals, diaphragm fatigue or premature parts failure.

NEW METALS & ALLOYS such as Tantalum, 316 Stainless and Monel are STANDARD materials of construction for the sealing DIAPHRAGMS. Other "wetted" parts are fabricated from 316 Stainless, Monel, Nickel and Hastelloy C—as you desire. A perfectly sealed measuring chamber filled with the celebrated silicone oil PROTECTS ALL WORKING PARTS.

INTEGRAL STEAM TRACED PROCESS FLANGES, available from our shipping shelves, enables one to conveniently heat process connections to prevent fluids from "freezing"—all without TROUBLESOME AND EXPENSIVE lagging and tracing in the field.

Obstructionless Flowmeters

THE JUSTLY CELEBRATED

MAGNETIC FLOWMETER

OF FISCHER & PORTER
one of the very best
instruments ever invented

An unobstructed length of pipe that accurately measures the flow of even the least conductive fluids by the Invisible MAGNETIC FIELD. Extends the range of accurate flowmetering to heretofore unbelievable limits. A rangeability of 3000:1! Measures the flow of any liquid with a conductivity of no less than 0.1 micromho per centimeter.

Measures flow IN EITHER DIRECTION and without auxiliary equipment. Handily provides full scale recording of ANY FLOW RATE from 1 to 30 feet per second at the TURN OF A DIAL.

Coupled with a
Fully Transistorized Recorder

Years ahead of its time! An instrument of the future which you can profitably use today. The new recorder incorporates compact transistorized circuits which have reduced space requirements incredibly. Now the entire instrument is contained in a SINGLE DEPTH CASE. No black boxes to add. All amplifiers are mounted on plug-in cards.

Gentlemen, the Magnetic Flowmeter itself represents the GREATEST ADVANCE in flowmetering in the last quarter century!

Integrating Flowmeters

TURBINE METER

Here is the zenith in flowmetering of the greatest accuracy over a wide range, designed for the most fastidious users. Each and every revolution of the bladed rotor in the TURBINE METER signifies the passage of a definite unit of fluid volume with an ELECTRICAL pulse. The total number of counts is proportional to the total volume of FLUID PASSING THROUGH the meter.

NEW ! NEW ! NEW

TRANSISTORIZED
READOUT DEVICES

The Turbine Meter can be linked with any of an unbelievable number of Readout Devices to oversee your process operations. Exemplary devices, utilizing the most up-to-date transistorized electronic components and techniques can indicate, totalize, record and control.

Continuous In-Line Blending

NOW A FACT

Triumph at last. To the marriage of the amazing Turbine Meter and Marvelous Electronic Readout Devices goes a new distinction. Together they have brought to reality a truly Continuous IN-LINE BLENDING System for blending of two or more fluids. This combination offers to you many other solutions for conquering DIFFICULT & DEMANDING & COSTLY flowmetering operations.

YOUR ATTENTION INVITED!

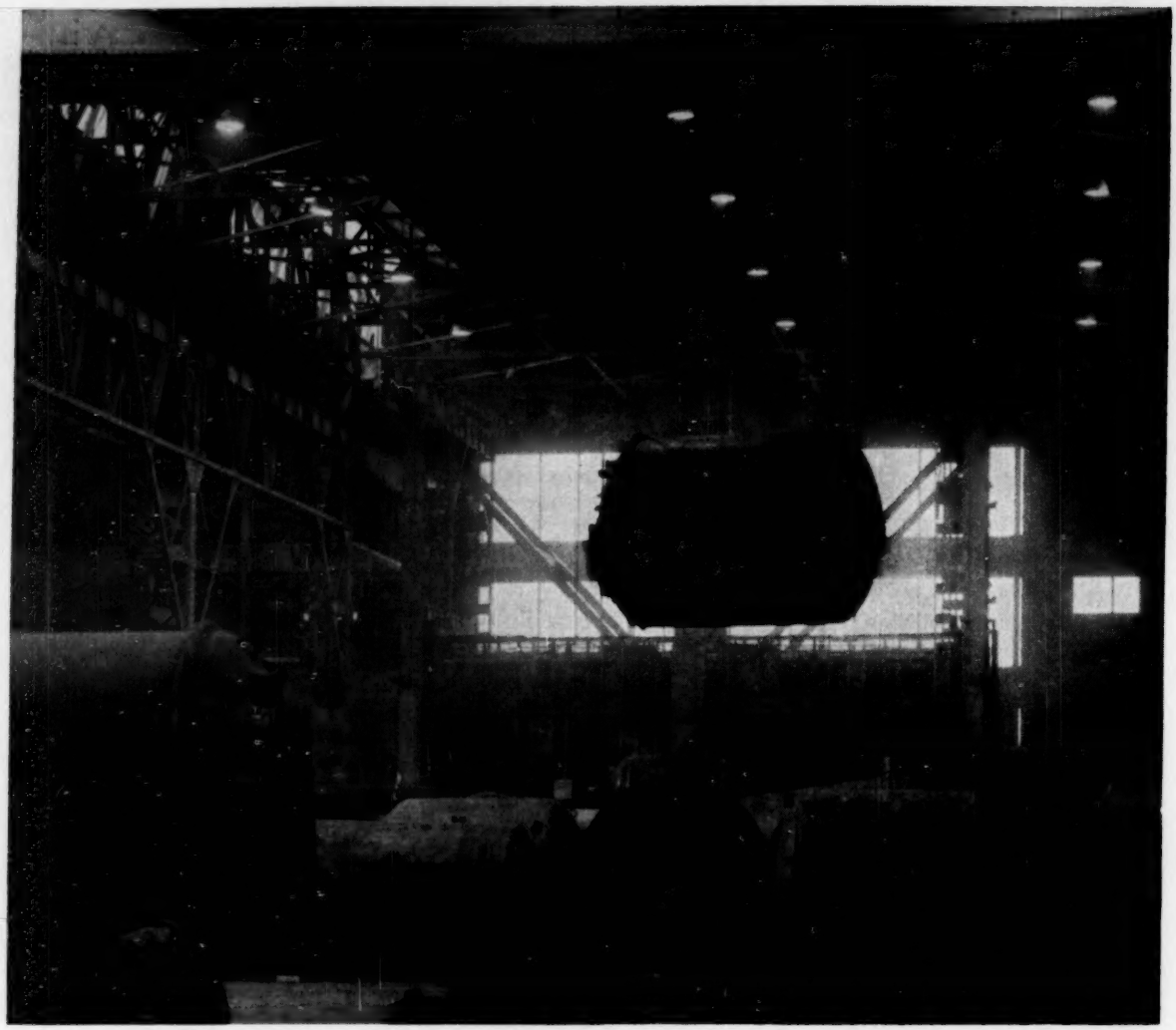
STATE YOUR PLEASURE, GENTLEMEN!

To better acquaint our public with the BENEFITS and ADVANTAGES of our UNIQUE products we have caused to be printed handsome booklets for the general edification. We will gladly post to you a selection of these works upon your application. It will only require an expression as to the type of meter(s) of interest, that is Variable-Area, Variable Head, Obstructionless and Integrating and also our "handy" Guide (91-119). We are your obedient servants in this as in all other matters.

FISCHER & PORTER CO.
WARMINSTER, PENNSYLVANIA & TORONTO, CANADA

A world-wide INSTRUMENT COMPANY with plants in Australia, England, France, Germany, Holland, Mexico, as well as the U.S.A.

FLUIDICS* AT WORK



New from Pfaudler . . . plastic-coated process equipment to fight corrosion

Equipment of the type shown in the picture above is now available with a corrosion-resistant plastic coating.

The new coating is called Pfaudlon 301.† Developed by our Pfaudler Division, it consists of a water suspension of Penton‡ which is sprayed on and then fired.

Pfaudlon 301 coatings generally can be supplied in 20-40 mil thickness, completely free of "pinholes." It is resistant to the corrosive effects of virtually all acids and alkalies as well as many solvents at temperatures up to 210°F. For certain pre-evaluated services, you may be able to operate at even higher temperatures.

Pfaudlon 301 coats to the desired thickness and forms a hard, nonporous-type surface with as few as two applications. Other plastic coating methods usually require four or more applications.

The coating of complex shapes presents no problem. We've coated such items as agitators, centrifuge baskets and parts, valves, pump impellers and casing, and process tanks—*inside* and *out*. (Note: It is easy to exclude those surfaces that need no coating.)

You also have quite a choice in base metals. We've had good results applying Pfaudlon 301 to mild steel, cast iron, stainless steels, the Hastelloys, brass, bronze and copper.

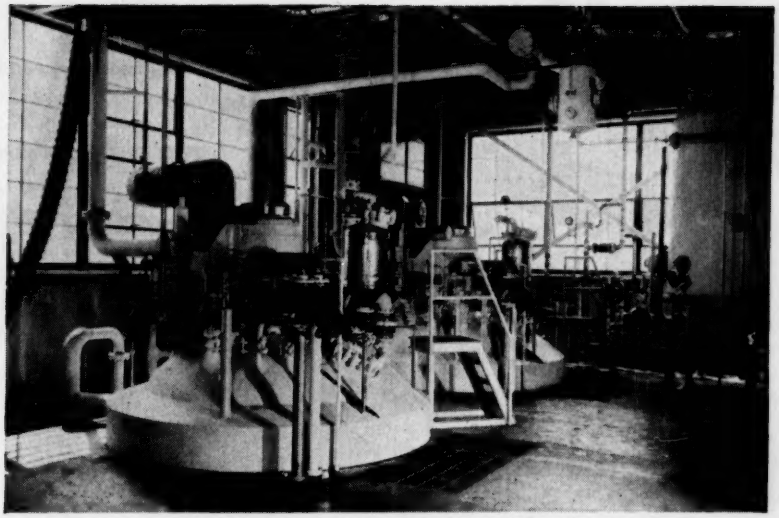
Inside valves, pumps, tanks or what have you, Pfaudlon 301 will permit you to handle *safely* a seemingly endless list of materials. Like? Most acids and alkalies, hydroxides, fluorides and oxides, plating solutions, tanning liquors, crude oil, alcohols, and kerosene, to name a few.

Applied to the *outside* of equipment, Pfaudlon provides exceptional protection against the effects of acid spillage and corrosive atmospheres.

New Pfaudlon 301 will be available in two ways: To custom-coat your existing equipment, or components; we have licensed eight firms around the country. You will find their names listed in the box on the opposite page.

From us, direct, you can get new equipment, fabricated and coated, from either of our two plants. Additional facts covered in a new data sheet, now available.

†Patent applied for
‡Registered trademark for chlorinated polyether manufactured by Hercules Powder Company.



This polymer plant was designed and engineered by Pfaudler as part of its Project Engineering service.

When should you use our Project Engineering service?

Whenever a new plant or expansion requires a temporary addition to your engineering staff, is the concise answer.

Starting with your data, since we do not supply the process or process data, we can provide you or your engineering firm with an integrated design to achieve the required operations and controls.

In essence, our Project Engineering service includes any or all of these functions:

1. Design of system or plant
2. Selection and specification of equipment
3. Layout
4. Procurement and expediting of equipment
5. Contracting for erection, installation and/or construction
6. Start-up assistance and personnel training

We offer specialized experience in solvent recovery — column design — esterification — and polymerization. Our group has designed plants for chlorine dioxide, detergents, resins, and recovery of metal finishing wastes . . . to name the more significant areas.

Where and when we start and how far we carry a project is your decision. A preliminary conference can be arranged at any time.

Please direct all inquiries on Project Engineering services, Pfaudlon 301 coatings, and F-C Glasteel pipe to our Pfaudler Division, Dept. CE-31, Rochester 3, New York.

PFAUDLON 301 LICENSEES

American Durafilm Co., Inc.
2300 Washington Street
Newton Lower Falls 62, Mass.
WOodward 9-9800

Mercer Rubber Corporation
66 Reade Street
New York 7, New York
BArclay 7-0140

Electrochemical Engineering & Mfg. Co.
750 Broad Street
Emmaus, Pennsylvania
WOodring 5-9061
(Rt. 215 + LL)

Tank Lining Corporation
Seminary Avenue
Oakdale, Pennsylvania
BRowning 6-3205

Livingstone Coating Corporation
709 W. Third St., P. O. Box 8282
Charlotte 8, N. C.
EDison 4-1097

Inner-Tank Lining Corporation
4777 Eastern Ave.
Cincinnati 26, Ohio
EAst 1-4777

Industrial Coatings Corporation
3227 S. Shields Ave.
Chicago 16, Illinois
Victory 2-4828

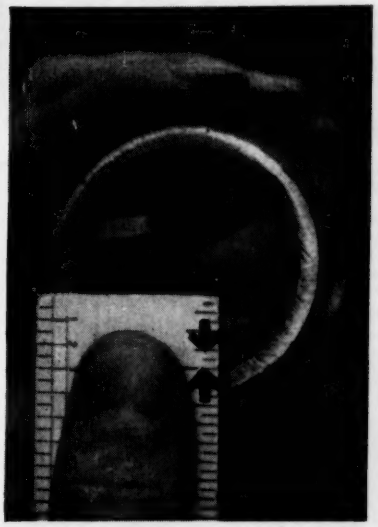
Hanszen Plastics Co.
835 S. Good-Latimer Expressway
Dallas 10, Texas
RIverside 8-8745

An inside look at F-C Glasteel Pipe**

This is the glass-lined pipe that you can cut to length with any standard dry-abrasive cutoff wheel and then, with a minimum of effort, thread, fire-polish and belt-sand for tight flange connections.

An "inside" look shows another important feature of this high-integrity, lined pipe. The glass lining is not a coating. Rather it is a ⅛-inch *thick* special glass piping permanently fused to the shell of the outer steel pipe.

This means you can expect substantially long service life, even with corrosive and/or abrasive fluids. That glass inside also protects product purity. And it's fire-polished smooth for complete cleaning with a minimum of effort. Outside, of course, the steel provides working strength.



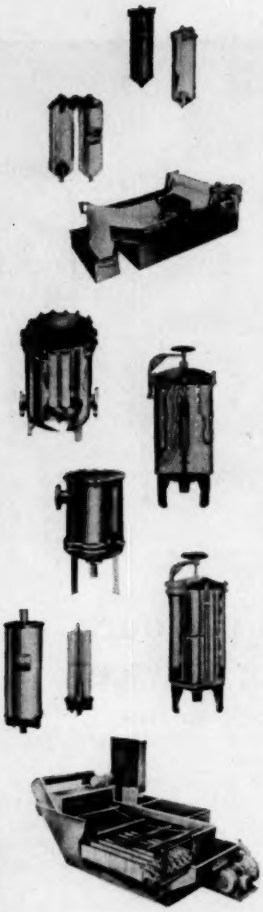
Put F-C Glasteel pipe to work with all acids (except HF) to 350°F. Pipe through most alkalies at moderate temperatures. Handle ultra-pure liquids without concern over contamination from the pipe.

Get it in 1½-, 2- and 3-inch diameters, in any length up to 10 feet, right "off the shelf." For answers to your questions, write for a copy of Bulletin 987.

**Patent applied for

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.
Specialists in FLUIDICS . . . the science of fluid processes



4311

CFC MODELS AND MEDIA TO MEET YOUR FILTRATION NEEDS

The standard line of CFC filtration equipment includes over 4311 different models and media. And if one of these isn't ideal for your application, CFC will engineer a filter to your exact needs.

CFC filters all types of industrial fluids — from Air to Zinc Cyanide — from 1 gallon per hour to 2700 gallons per minute. The complete line includes **FULFLO** Filters with media made from a wide variety of natural or synthetic fibres, resin-impregnated paper, sintered or woven metals and porous ceramics for precise filtration of liquids and gases; **HONAN-CRANE** Filters with fibre, resin-impregnated paper or adsorptive earth media for industrial oils; **DELPARK** Continuous Filters for cutting oils, coolants and other industrial liquids.

Look to CFC Filters — to improve product quality, cut maintenance and production costs, protect valuable equipment and reduce costly down time. Write for catalog or engineering assistance to Dep't CE.

CFC

COMMERCIAL FILTERS CORPORATION

Fulflo Honan-Crane Delpark Mishiana

MELROSE 76, MASSACHUSETTS

PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

Kellogg Engineering Teamwork at Work:
on an international chemical project in New Jersey

DEVELOPING A SUCCESSFUL COMPLEX

CIBA and Kellogg—both world-wide organizations—have been associated in the U.S. as client and contractor in chemical plant engineering and construction since 1955. Working with a New Jersey affiliate of the Swiss company, Toms River Chemical Corporation, Kellogg engineers have helped expand this firm's facilities from a single vat dye plant into a major complex of five plants.

Each of the four new chemical plants produces different materials—azo dyes, Araldite* epoxy resins, anthraquinone, and epichlorohydrin. The last two are intermediates, or raw materials, used in the original dye plant and new resin plant respectively.

In all four cases, Kellogg and client worked as an engineering team—sharing in varying degrees the responsibilities for process and design engineering, procurement, and construction. Considerable design data were originated by CIBA in Switzerland.

This international blending of technology has resulted in the maximum utilization of experience by client and contractor, and in the optimum over-all capital investment for Toms River Chemical Corporation.

If you are planning to build new processing facilities at home or abroad, Kellogg would be glad to show you how its engineering teamwork could work to your company's advantage. Please address inquiries to The M. W. Kellogg Company, 711 Third Avenue, New York 17, New York. *REGISTERED TRADEMARK

THE M. W. KELLOGG COMPANY / A Subsidiary of Pullman Incorporated

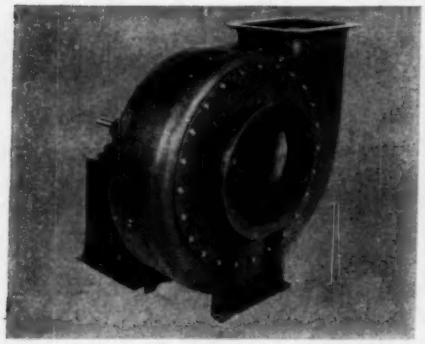
Offices of other Kellogg companies are in Toronto, London, Paris, Rio de Janeiro, Caracas, Buenos Aires

M KELLOGG W

The HARMFUL EFFECTS of corrosive contaminants have been the concern of 'Buffalo' Engineers for many years. They have designed a line of air and liquid handling units to combat the destruction to property and health inherent in many industrial processes. Here are some of these units. When you must handle corrosives safely or render them harmless, call on your resident 'Buffalo' Engineer.

CONTROL CORROSION

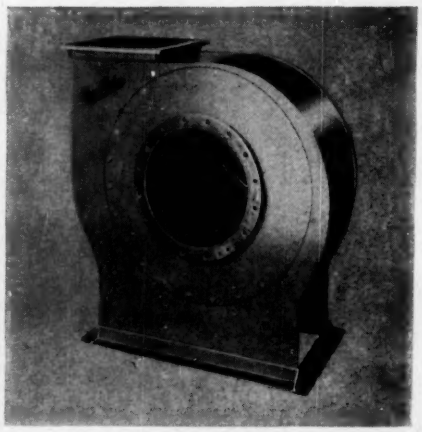
with 'Buffalo' air and liquid handling equipment



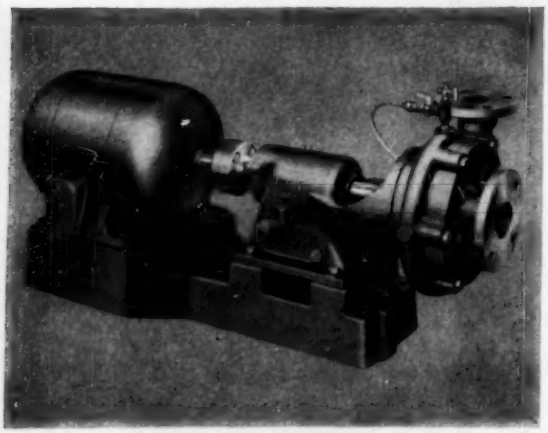
'Buffalo' Fiberglass Fume Fan

'BUFFALO' FIBERGLASS FANS — give excellent resistance to severe corrosive conditions, especially against salts, acids, gases, organic and other materials. Suitable for temperatures to 225°F and higher, this material is impact resistant and will not support combustion. No metal parts are exposed to the air stream. In true rated capacities to 34,000 cfm. Bulletin FI 511.

'BUFFALO' RUBBER LINED FANS — have a rubber coating "welded" to all metal parts exposed to the air stream. Where a fan of this type is needed, they usually outlast ordinary fans 3 to 12 times, far exceeding in useful life the small additional cost. Bulletin 2424-F gives complete details. In addition to fiberglass and rubber lined fans, 'Buffalo' offers a variety of materials of construction including stainless steel, brass, monel and many special coatings.



'Buffalo' Rubber Lined Fans



'Buffalo' Chemical Liquid Pumps

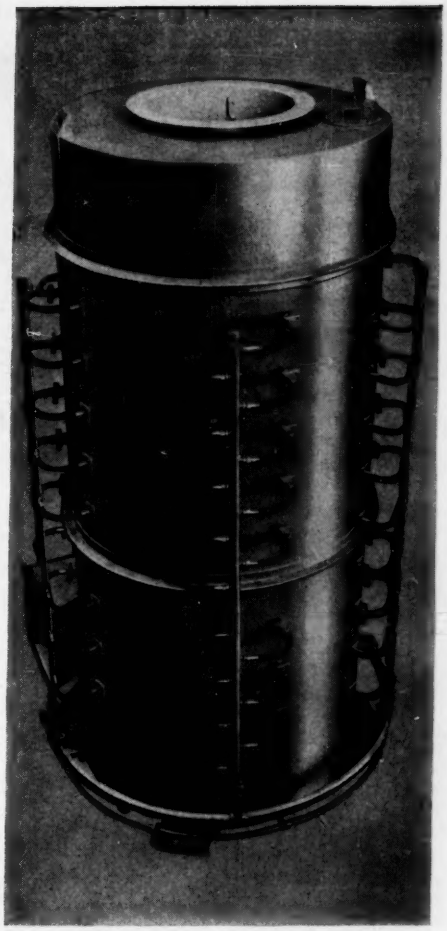
'BUFFALO' CHEMICAL LIQUID PUMPS — are built of iron, stainless steel, monel, nickel, bronze, Hastelloy B&C, Ni-resist and manganese steel. These pumps are of modern, efficient design. Parts are standardized and interchangeable. Bulletin 982. In addition, 'Buffalo' offers lead acid pumps and rubber lined pumps. Write for details on complete 'Buffalo' line of corrosion resistant pumps.

'BUFFALO' AIR CLEANING EQUIPMENT is backed by over 50 years experience. Here are some of the effluents tamed by 'Buffalo':

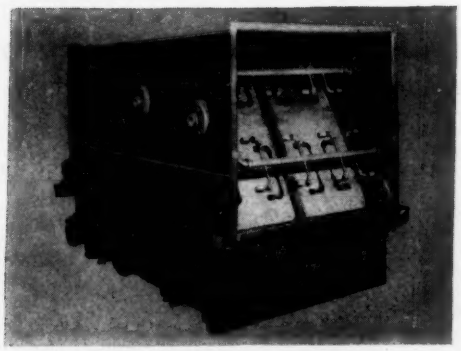
SO_2 and SO_3 process gases (recovered)	Soluble gases, vapors, mists
Tar Vapor	Coke Breeze
Lampblack	Metallic fumes
Heavy dusts, rock dusts	1000°F corrosive gases
Acid Mists	

Your toughest air cleaning problems are welcomed by 'Buffalo' Engineers. They have the ability to research, design and construct new equipment when necessary to give you complete satisfaction. They are thoroughly familiar with latest design advances and specialized materials of construction. Let 'Buffalo' solve your next effluent problem. You and your "neighbors" will be highly pleased.

'BUFFALO' HYDRAULIC SCRUBBING TOWERS utilize a finely atomized spray and inertial separation of the contaminant from the gas stream in a cylindrical tower. They are highly efficient and require little maintenance. Available with corrosion-resistant linings, or can be fabricated from special materials at minimum cost. Wide range of applications includes fine dust and mists, metallurgical and chemical fumes. Bulletin AP-525 gives complete details.



'Buffalo' Hydraulic Scrubbing Tower



'Buffalo' Gas Absorber

'BUFFALO' GAS ABSORBERS consist of three basic components: 1. Wetted impingement-type cells for removal of particulate matter. 2. Wetted fiber cells for absorption of gases. 3. Dry fiber cells for elimination of fine droplet carryover from the unit. These efficient units are widely used in treating effluents from such difficult applications as laboratory hoods and open surface tank operations. Wide range of materials of construction are available. Write for Bulletin AP-125.

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

'Buffalo' air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

Squier machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

HERE'S A QUESTION WITH MORE THAN ONE ANSWER

Q: WHY DO DeZURIK VALVES EXCEL ON SO MANY CHEMICAL APPLICATIONS?

THEY SHUT TIGHT ON ANY SERVICE!
On liquids, slurries or gases, DeZurik Valves close — dead tight — every time. Their resilient plug facing provides a cushioned closure that seals around any solids intervening on the seat.

THEY OPEN EASILY EVERY TIME!
Because the plug in a DeZurik Valve touches the seat only in the closed position, there is no continual frictional resistance to overcome. Solids cannot be caught between the body and plug to bind or seize.

NO LUBRICATION NECESSARY!
Lubrication is not necessary to assure tight shut-off or easy operation. Nor is any other constant maintenance required to keep DeZurik Valves operable. Eccentric Action compensates for plug wear; the stem seal, under spring pressure, is self-adjusting; corrosion resistant bearing bushings prevent "freeze-up" in the journals.

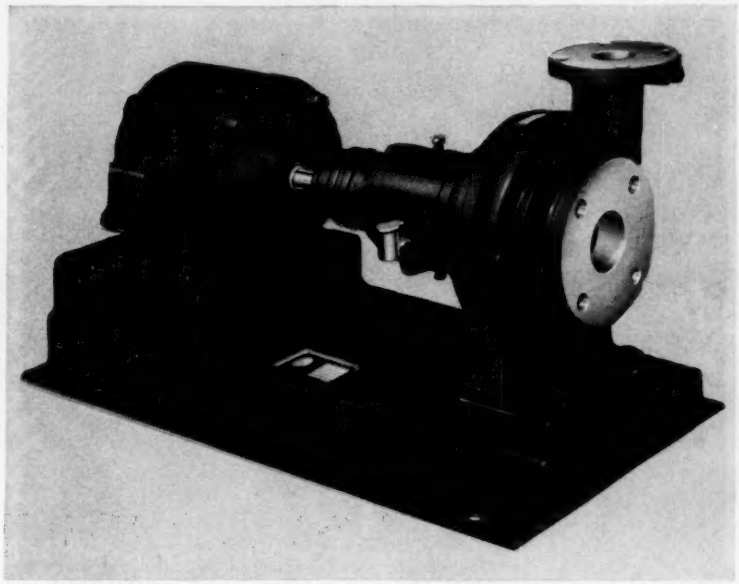
AVAILABLE IN WIDE RANGE OF MATERIALS!
DeZurik Valves are available in almost every castable material. (A variety of resilient materials for plug facing is available, too, where corrosion is a problem.) In addition, valves can be supplied with hard or soft rubber linings for use where abrasion is encountered.

These are not the only advantages of DeZurik Valves. Longer life, on-off and throttling service from one valve, greater capacity size for size.... and many other superior features. Ask the DeZurik representative in your area for more details, or write

DeZURIK Corporation
Sartell, Minnesota

prove it to yourself!

...THAT THE SERIES 1510-B CENTRIFUGAL PUMP OFFERS MORE



1510-B FEATURES

- Vertical split case design—solid-type volute can be left in pipe line when servicing pump.
- Removable bearing frame assembly—can be lifted out without disturbing piping or motor leads.
- Interchangeable bearing frame assembly—one unit fits a wide range of pump sizes.
- Positive oil lubrication with visual check.
- Anti-friction *roller bearings.*
- Mechanically balanced impeller. Balancing chamber and pressure relief holes in impeller reduce thrust to a minimum—lengthen pump life.
- Leak-proof "Remite" seal. Carbon seal ring faces on harder-than-glass Remite floating seat. Assures long, trouble-free life.
- Special alloy steel shafts, superfinished, oversized.
- Performance guaranteed—100% pre-tested at the factory for conditions of head and capacity specified.
- Choice of all-iron, bronze-fitted, or all bronze.
- Capacities to 2000 GPM, heads to 420 ft.

Why not get your full dollar's worth of pump value...send today for selection data on the B&G 1510-B Centrifugal Pumps.

Check any centrifugal pump of comparable capacities against B&G 1510-B Pump features!

B&G Series 1510-B Centrifugal Pumps are distinguished by all the features listed at left. To compare any other pump with the 1510-B, place check marks in the red boxes beside the features also offered by the competitive pump.

We'll wager you'll wind up with quite a number of unchecked boxes!

The balanced design of this *vertical split case* pump is definite assurance of smoother, more efficient performance and longer life. Its design enables the bearings to withstand loads far in excess of those produced by any pump and motor combination in the 1510-B series ...an added feature of dependability.

NOW AVAILABLE IN "C" SIZE UNITS UP TO 75 H.P.
2000 GPM, 170 feet, 1750 RPM,
3"—4"—6"—8" discharge connections

BELL & GOSSETT COMPANY
Dept. GO-14, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

WHICH JOB WOULD YOU TAKE?

If you're like most of us, you'd take the job with the more tempting salary and the brighter future.

Many college teachers are faced with this kind of decision year after year. In fact, many of them are virtually bombarded with tempting offers from business and industry. And each year many of them, dedicated but discouraged, leave the campus for jobs that pay fair, competitive salaries.

Can you blame them?

These men are not opportunists. Most of them would do anything in their power to continue to teach. But with families to feed and clothe and educate, they just can't make a go of it. They are virtually *forced* into better paying fields.

In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

At the rate we are going, we will soon have a very real crisis on our hands.

We *must* reverse this disastrous trend. You can help. Support the college of your choice today. Help it to expand its facilities and to pay teachers the salaries they deserve. Our whole future as a nation may depend on it.

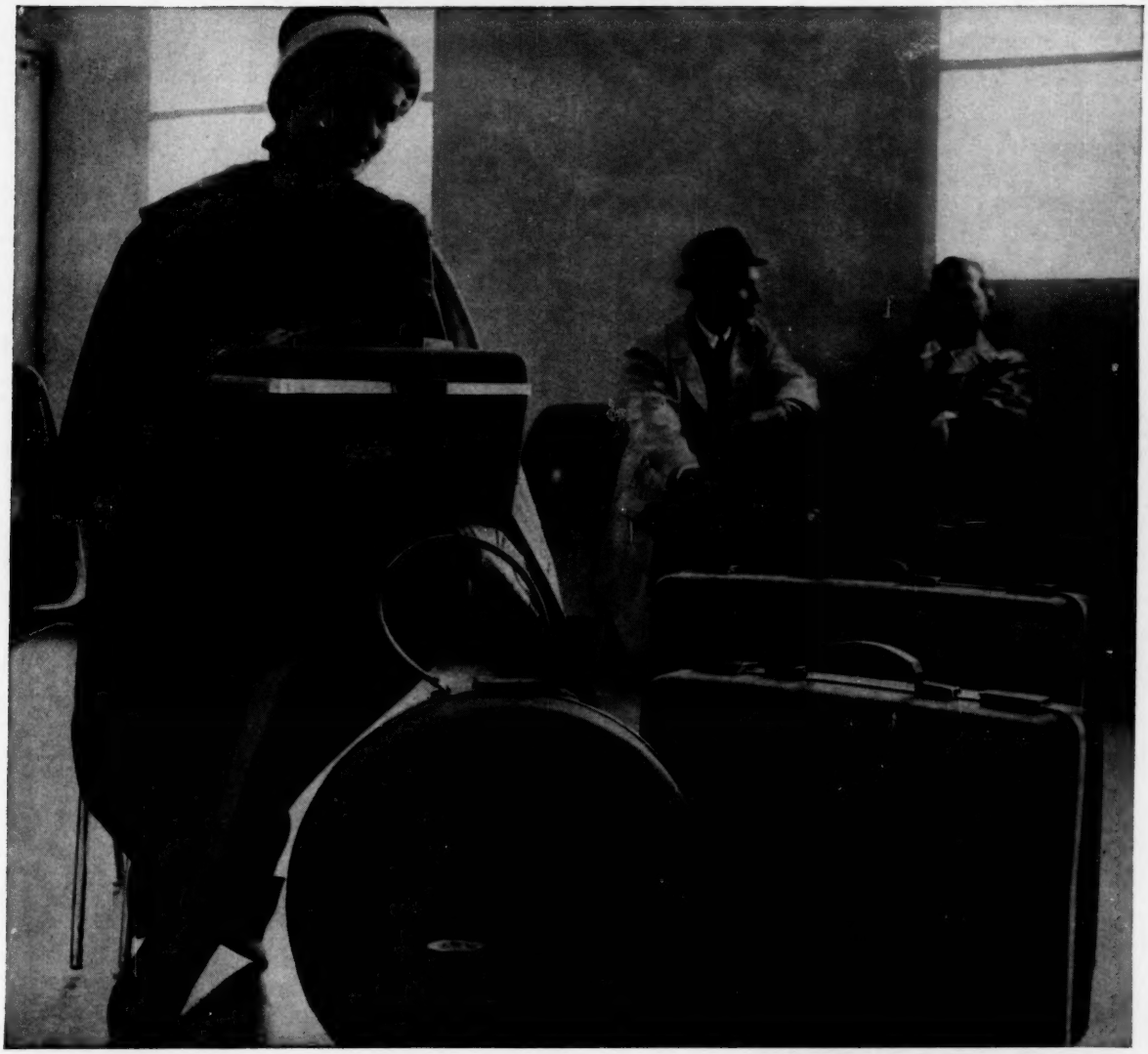
It's important for you to know more about what the impending college crisis means to you. Write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, N.Y.

ADVERTISING COUNCIL PUBLIC SERVICE

Sponsored as a public service, in co-operation with the Council for Financial Aid to Education

HIGHER EDUCATION KEEP IT BRIGHT

HOW *HERCULES* HELPS...



MAKE RUGGED LUGGAGE—Described by Sears, Roebuck and Co. as "the greatest step forward in luggage since leather," this new "Forecast" line based on Pro-fax®, Hercules polypropylene, is rugged, rich looking and virtually immune to staining. Distributed exclusively by Sears through its catalogues and 740 retail stores, "Forecast" luggage has been selected as a Diamond Jubilee Item for the company's 75th anniversary year.

PRODUCE HEALTHIER LIVESTOCK—Delnav® miticide, a development of Hercules' agricultural chemicals research, gives beef cattle, hogs, goats and sheep long-lasting protection from ticks and many other insect pests. Spray or dipping formulations based on Delnav require no waiting period between treatment and slaughter and avoid problems of excessive residues.

G61-2

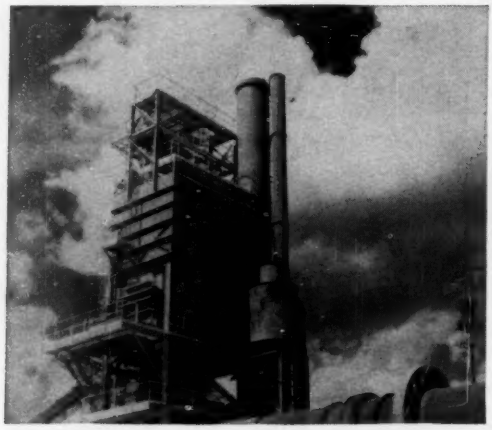
HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

CHEMICAL MATERIALS FOR INDUSTRY

HERCULES

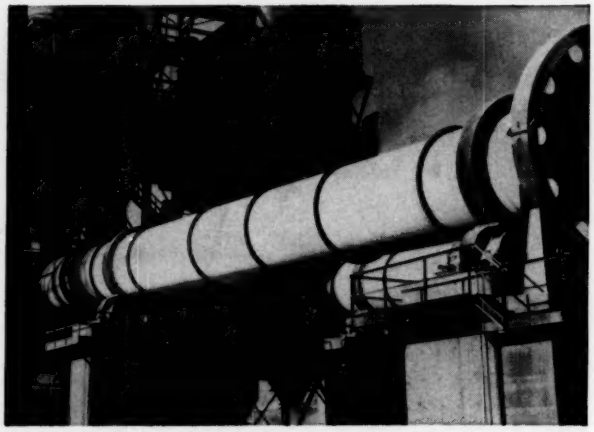
KENNEDY lime plant equipment

KENNEDY Stone Preheater



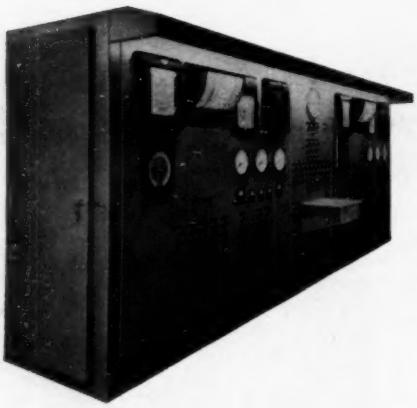
Puts kiln exit gases to work to partially calcine feed. The KENNEDY Stone Preheater makes the rotary kiln the most economical producer of high quality lime.

KENNEDY Short Rotary Kiln



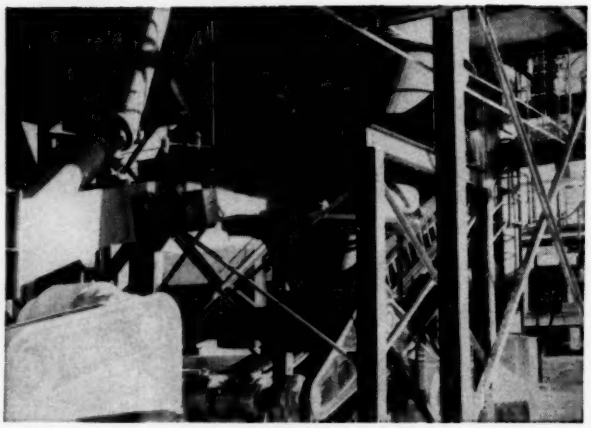
KENNEDY heat-saving auxiliaries make long kilns unnecessary. There is less kiln to buy and maintain; there is less brick — fewer foundations; alignment is simpler.

KENNEDY Centralized Kiln Control



A single, attractive cubicle houses all instruments essential to system control. Each is factory-assembled and checked to simplify installation and insure efficient overall operation.

KENNEDY Contact Cooler



Further economies are achieved by the highly efficient transfer of heat from the discharged lime to the combustion air, while rapidly lowering lime temperature. Unit requires little headroom.

We invite your request for further particulars.

KENNEDY VAN SAUN

MANUFACTURING & ENGINEERING CORPORATION

405 PARK AVENUE, NEW YORK 22, N.Y. • FACTORY: DANVILLE, PA.

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U.S.I. CHEMICAL NEWS

March ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1961

New textured metal coat for polyethylene squeeze bottles comes in range of colors.

Polyethylene Squeeze Bottles Get Metal Coat By New Vacuum Process

A new, modified vacuum-coating process for polyethylene squeeze bottles is claimed to produce adherent, textured metallic finishes in a choice of colors. Coatings applied by the new process are reported to stay on the bottle after many squeezings. The textured effect, which can be varied, is designed to eliminate glare and gaudy appearance, and to hide finger prints or other soiling. This surface takes printing without additional treatment.

Another advantage claimed for the process is that it tends to seal the polyethylene, and slow down the rate at which solvents and volatiles attack it or escape. Tests by the developer are said to indicate no measurable loss of either isopropanol or lube oil after a month in the finished bottles. Nor did these materials cause breakdown of the coated surface.

The process is being recommended for cosmetic containers, toys, etc. and is reported to be competitive on cost with ordinary vacuum metallizing of plastics.

Need for Vitamin E Found To Rise with Intake of Unsaturated Fatty Acids

Recent investigations have been conducted on the relation between unsaturated fatty acids in the diet and the body requirement for tocopherol (vitamin E). Results indicate that, although an intake of 5 mg per day of α-tocopherol may be enough for an adult having low stores of linoleic acid, intake of large amounts of vegetable oil over long periods can up this requirement to 30 mg per day.

MORE

Titanium Now Competes on Cost, For Fabricating CPI Equipment

Market for Titanium Going Up Because of Lower Prices, Stepped-Up National Defense Program

Titanium producers are now bidding for CPI equipment jobs on a cost and performance basis against common construction materials such as lead, copper, stainless steel and special nickel alloys. They believe it is no longer necessary to compete on long life alone, because titanium sponge now sells for $1.60 per pound (against $2.75 in early 1957). Thus, titanium's desirable properties, other than corrosion resistance, are now important sales advantages.

Equally important, fabricators are now more familiar with the working characteristics of the metal. Many of them have developed cost- and trouble-saving techniques for welding and other fabrication operations.

Titanium Heater Coils

For example, a recent report states that titanium heater coils are now being fabricated for sulfuric acid—metallic sulfate service in metals production. Here, titanium's ability to shed corrosion products, rather than its corrosion resistance, was the reason for its selection. In this environment, corrosion products evidently build up on coils and cut heat transfer rate. In contrast to the material previously used for these coils, the titanium is said to shed corrosion products when tanks are simply flushed with boiling water. No scrapping, chipping, or brushing is needed.

MORE

Typical CPI application for titanium is this caustic scrubber column (16 in. diam., 23 ft. long). Photo courtesy Pfaudler Permutit, Inc.

Fuel Cell Being Developed Uses Sodium, Oxygen, H_2O

According to recent reports, sodium metal is being used to fuel a new type of cell for the production of electric power. Such cells are being incorporated into a power plant prototype now under development for the Navy.

Employing the reaction of sodium with oxygen and water, these cells are claimed to have an efficiency of 60%—much higher than hydrogen—or hydrocarbon-burning cells. It is reported that they develop almost twice the voltage and current density of the hydrogen-burning cells, so that fewer cells can do the same job. Also the sodium, which is in the form of an amalgam, is easier to store than is hydrogen.

The cells weigh 2-3 lbs./kwh of capacity, including fuel storage, which is said to be only 1/30 the weight of lead-acid storage batteries of equivalent power output (75kw).

Black Polyethylene Resin Now Offered for Coatings

Black pigmented polyethylene resin for extrusion coating onto paper, paperboard or aluminum foil has just been introduced by U.S.I. This resin is expected to find application in products such as automobile door liners, agricultural mulch-coated paper and packages for photographic film or paper.

Coatings 0.75 mil (19 microns) or greater made from PETROTHENE® 201-220 polyethylene resin provide an effective light and moisture barrier. Good carbon black dispersion and the absence of non-homogeneous particles also contribute to the light-tight barrier properties of the resin. Adhesion onto paper or paperboard is excellent. For coating aluminum foil, a primer is necessary for good adhesion.

For literature on this resin, address Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., New York 16, New York.

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March ★ **U.S.I. CHEMICAL NEWS** ★ 1961

CONTINUED

Titanium

A prototype titanium coil has already lasted three years in service, and is still in excellent condition, according to the report. The material previously employed lasted only nine months before corrosion build-up made it unusuable.

Titanium for Defense

Thanks to the above factors, plus a stepped-up national defense program, the market for titanium has been going up. Production and sales in 1960 are estimated at over 7 million pounds, according to Reactive Metals—the integrated titanium producer owned in part by U.S.I.'s parent company, National Distillers.

Titanium weighs only about 55% as much as steel; is impervious to corrosion from salt water or acids. Some titanium alloys retain their integrity at temperatures up to 2,000°F. for short periods. That's why large quantities of the metal are going into the B-70 bomber program; into the Army's "Davy Crockett" program for equipping foot soldiers with a lightweight automatic weapon; into space vehicles and missiles; and into jet engines.

CONTINUED

Vitamin E

Prior to study, experimenters reasoned from two facts that dietary tocopherol needs might be proportional to fatty acid levels in the diet. The facts were: tocopherol acts as an antioxidant in normal tissues; unsaturated fatty acids, incorporated into depot fat as a result of high intake, increases the susceptibility of the fat to autooxidation.

Studies with both animals and humans have supported this reasoning, it is reported. In consequence, the researchers feel that those who advise supplementing the diet with vegetable oils should also provide for greater intake of tocopherol.

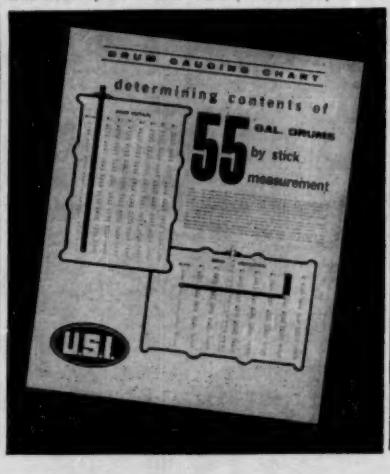
Have You a New Product To Tell the World About?

Make it routine to send your publicity releases on new products and developments to the Editor of U.S.I. Chemical News, often called the "Front Page of the Chemical Process Industries."

New Drum Gauging Chart Offered by U.S.I.

A new drum gauging chart, for determining how much liquid is left in an open drum, is now available from U.S.I. The new wall chart covers both 30- and 55-gallon drums. It converts wet inches of stick measurement to gallons of liquid—for drums gauged horizontally or vertically—at temperatures from 30°F. to 90°F. The chart is designed specifically for gauging ethyl alcohol, but can be used for any liquid with a similar coefficient of cubic expansion.

Copies may be obtained by addressing Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., N.Y. 16, N.Y.



TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Reagents and dye solutions for paper chromatography and electrophoresis now available in 200 ml aerosol spray bottles. Frees operator from dependence on air pressure lines. Protects reagents against contamination. **No. 1690**

Complete line of first aid kits and pharmaceutical supplies for industrial, institutional or professional use is described and illustrated in new, 28-page catalog now offered. **No. 1691**

Butyl myristate, butyl palmitate, butyl stearate now offered in 99.8+% purity. Because of high purity, these fatty acid derivatives are claimed useful as gas chromatography standards. Vapor phase chromatograms available for all 3. **No. 1692**

New particle counter is self-contained instrument said to be useful both for research work, and for monitoring particulate matter in atmospheres of such areas as clean rooms for precision manufacture and assembly. **No. 1693**

Lithium aluminum tri-t-butoxy hydride, new complex hydride that reduces acid chlorides to aldehydes, now available in lab quantities. Also useful for stereospecific reductions of steroid ketones to hydroxy derivatives. **No. 1694**

Amino acid analyzer described in new brochure. Gives features and use of instrument for automatic analysis of protein and peptide hydrolyzates, physiological fluids, tissue extracts, foods, culture media, pharmaceuticals. **No. 1695**

New fatty hydroxamic acids, now produced commercially as chemical intermediates, have reactive OH and NH group as well as long, straight chain fatty group. Can react with alkalis, metallic ions, acylating agents. **No. 1696**

Mathematical puzzles and pastimes are subject of book now being sold. Puzzles based on match-stick geometry, "once-over" curves, perpetual calendar, etc. Includes 100s of puzzles, answers, explanations, current applications. **No. 1697**

New iodine titration indicator is said to be stable, with good shelf life, and to be readily soluble in cold water, giving clear colorless solution. Reacts with iodine in presence of iodide, forming deep blue complex. **No. 1698**

Radioactive tracers, tagged compounds, sources, handling equipment, instruments, film badge service, health physics survey, environmental testing described in new catalog now offered. **No. 1699**

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PETROTHENE® . . . Polyethylene Resins

MICROTHENE . . .Finely Divided Polyethylene Resin.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P.

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Intermediates.

Ethyl Alcohol: Pure and all denatured formulas; Anhydrous and Regular Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL®M, ANSOL PR

Heavy Chemicals: Metallic Sodium, Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Sodium Peroxide.

Animal Feed Products: DL-Methionine, MOREA® Premix (to authorized mixer-distributors).

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You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

_____

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_____

National Airoil offers IMPROVED Model CP Vertical Firing Combustion Units

Here's big news! Now available is the *improved* National Airoil Model CP Vertical Oil Firing Combustion Units, ideally suited for use with stills, heaters, super-heaters, vaporizers, air-heaters, and other process furnaces in refineries, oil producing fields, and chemical plants. The units are used extensively in vertical and horizontal tube heaters of either cylindrical or box types. The units also are available for gas fuel and combination gas and oil.

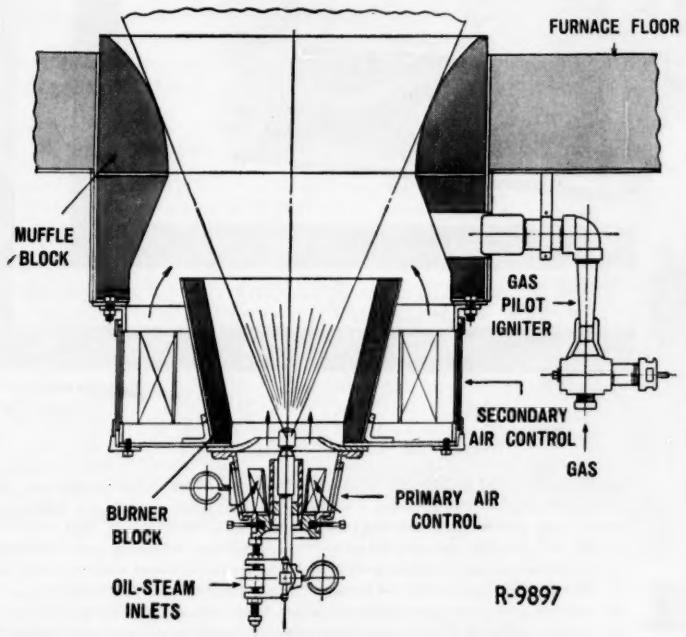
These modern CP oil units have added features that result in:

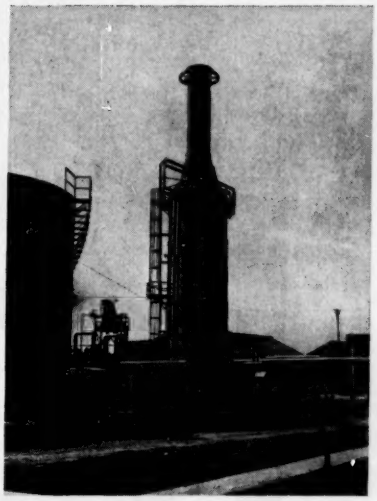
- **More stable fuel ignition.**
- **Higher economy of oil combustion with a minimum of excess air.**
- **Cleaner flames without dripping on heavy fuel oils.**
- **Flame patterns commensurate with furnace shape and arrangement of heat absorbing surfaces.**
- **Maximum radiation of heat from oil flame.**
- **Susceptibility to a varying demand of heat load.**

National Airoil CP oil units are available in six standard sizes that readily take care of the range of capacities most frequently specified. Two other special sizes are available for unusual conditions.

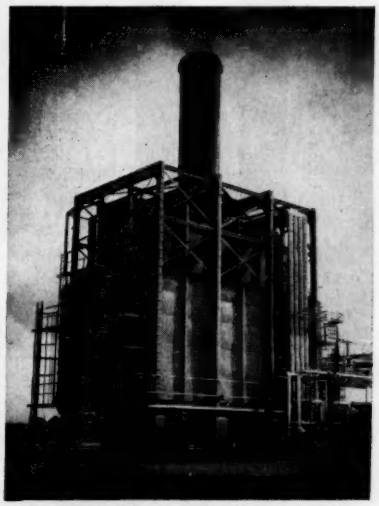
The units can be supplied to perform on natural or forced draft. On natural draft, they can be adapted to automatic combustion control, working the secondary air register. A different adjustment can regulate forced draft.

Where required, the CP units can be equipped with the dependable National Airoil Pilot-igniter Gas Burner for either continuous burning at 1% of the total heat load, or for intermittent operation as for ignition or start-up. Also, they can be furnished with the reliable National Airoil Electric Ignition System as used in chemical plants throughout the world.





Vertical cylindrical oil heaters perform more satisfactorily when operated with National Airoil CP Combustion Units.

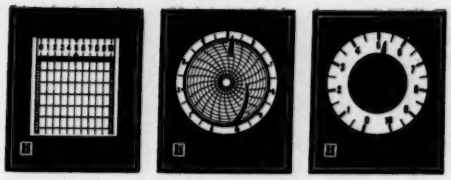


National Airoil CP Combustion Units are ideal for use on horizontal tube, box furnaces like the one pictured here.

A National Airoil Representative will be happy to discuss how these improved CP combustion units will assure increased performance in your installation. Descriptive literature is available. Write today.

the advanced, all-new **ElectroniK 17**

NO SLIDEWIRE, NO SLIDEWIRE PROBLEMS. The unique STRANDUCER rebalancing element replaces the conventional slidewire. It works on the strain gage principle and consists of four looped wire strands which form the resistance legs of a Wheatstone bridge. Both STRANDUCER and pen carriages are linked to the potentiometer balancing motor. A change in electrical input causes the balancing motor to change the tension—and electrical resistance—of the STRANDUCER, to reposition the instrument pen or pointer. The STRANDUCER is unaffected by corrosive atmospheres and has no contactors. It has unusually long life and infinite resolution and is unaffected when the instrument operates in ambient temperatures up to 130° F.



will save you more time, trouble, dollars, and maintenance than any other potentiometer on the market today!

- New *STRANDUCER** replaces slidewire
- New control system with plug-in units
- New modular construction
- New economy

. . . and other pace-setting features

ElectroniK 17 potentiometers are completely new Honeywell recording and control instruments, compact enough to fit standard 19-inch relay racks. They perform reliably, have ±0.25% calibrated accuracy and incorporate new design advances which make them the easiest of all potentiometers to operate, convert, and maintain.

You can get *ElectroniK 17* instruments as strip or circular chart recorders or circular scale indicators. You can get electric contact control with up to 8 contacts. Control units are of plug-in type.

With *ElectroniK 17* potentiometers, you not only get uninterrupted performance, but also save money in initial cost, operating expense, and maintenance. You will find this new potentiometer far more economical to operate than any other available today.

For complete information on the *ElectroniK 17*, call your nearby Honeywell field engineer or write to MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. — In Canada, write Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

MODULAR CONSTRUCTION, PLUG-IN COMPONENTS

make ElectroniK 17 easiest of all potentiometers to operate, convert, maintain.

INTERCHANGEABLE DISPLAY MODULE. You can switch easily from strip to circular chart, to circular scale operation . . . reduce your spare parts inventory because you can stock a single spare module for several instruments.

FRONT ADJUSTMENTS. You adjust damping and gain from the front of the instrument, using only a screwdriver.

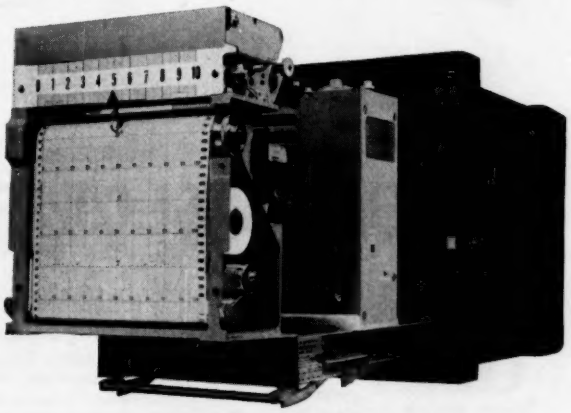
QUICK-CHANGE DRIVE GEARS. You can change chart speed to ½ or 2 times basic speed in a matter of seconds by replacing quick-change drive gears. Standard chart speeds: 1, 2, 6, 10, or 60 inches per hour.

EASY RANGE AND ACTUATION CHANGE. Simply change range card attached to actuation board. Universal reference junction compensator serves *all* types of thermocouples; you can quickly remove it to convert to some actuation other than thermocouple. Filter network rejects loop stray signals.

PULL-OUT CHASSIS AND EXTERNAL TERMINAL BOARD. You can pull out the chassis to the service position without tools and without interrupting the operation of the instrument, or completely remove it.

COMPACT EASILY-REMOVED TRANSISTOR AMPLIFIER. With only a screwdriver you can remove the amplifier for servicing.

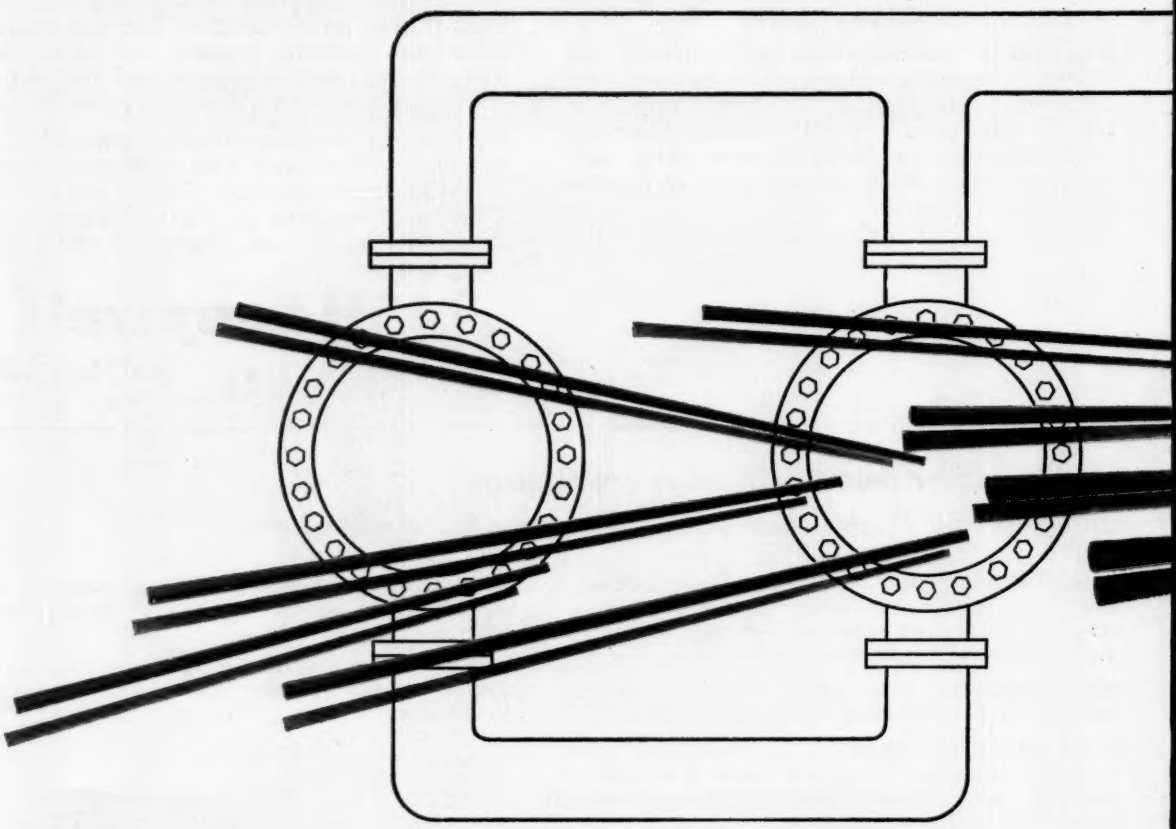
NO STANDARDIZATION. Zener diode constant current unit does away with need for battery and standardizing mechanisms.



**Trademark*—Minneapolis-Honeywell Reg. Co.

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

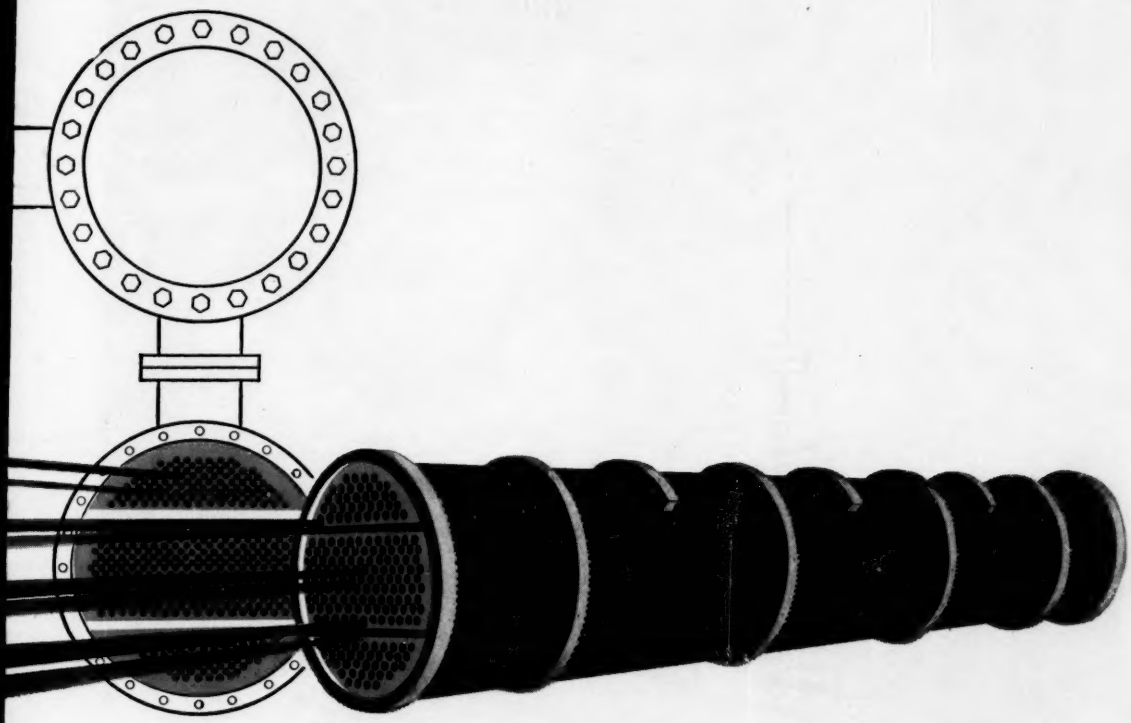
Need tubes for heat exchangers, condensers, evaporators, coolers, feed-water units?



PHELPS DODGE COPPER-BASE ALLOY TUBES have a

Wide line of finest quality copper-base alloys for every kind of application need—including bi-metal combinations.

National warehouses, completely stocked, in Houston, Beaumont and Corpus Christi, Texas, Baton Rouge and Lake Charles, La., Tulsa, Los Angeles, and South Brunswick, N. J., to serve customers from coast to coast.



reputation for reliable "On-Stream" Performance!

Expert engineers to help you solve tube corrosion problems, select the exactly correct alloy for your applications.

Specify the best—at the same cost as the rest!

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CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Tampa, Washington, D. C.

Inadequate fire protection. Result: a staggering fire loss at this refinery.

This fire need never have spread!

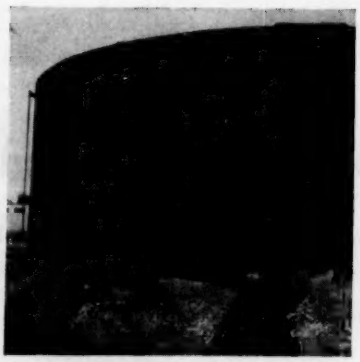
This tank fire did tremendous damage. 30 hours after it started, it was still crumpling storage tanks, buckling railroad cars, twisting track.

Grinnell ProtectoFoam Systems could have saved many of these tanks

When fire breaks out, a Grinnell ProtectoFoam System is ready to go into action. It quickly spreads a uniform blanket of fire-choking foam that covers and extinguishes the blaze. Surrounding tanks are saved.

Grinnell offers you fire protection systems for petroleum products, chemicals, alcohols, solvents, paints, liquefied gas. You benefit from 90 years of fire protection experience when Grinnell designs and installs your systems.

Free 16mm. Sound-Color Film. Grinnell's 35-minute film — "Fire Protection Through Research" — demonstrates all types of special fire hazards, and how to guard against them. To borrow this film — without charge — write: Grinnell Company, Providence 1, Rhode Island.



Grinnell ProtectoFoam protection. This bulk oil storage tank is guarded against destruction by fire.

GRINNELL

FIRE PROTECTION SYSTEMS SINCE 1870

The Temperature Control Powered by the

IRREPRESSIBLE FORCE OF MERCURY—

for Accuracy with Rugged Dependability

All Partlow temperature controls are directly and positively actuated by mercury, the metal in liquid form whose reaction to changes in temperature is as predictable as it is powerful.

Unlike delicate electronic controllers, the mercury-actuated Partlow requires no outside power source. No amplifiers. No finicky levers. And no "babying"! With a Partlow you can be sure of getting accurate, dependable control even under extreme conditions of shock and vibration.

Mercury-actuation makes possible maximum design efficiency and simplicity too. The Partlow has fewer parts to go wrong. And fewer service problems (with less "down" time) should trouble occur. You can replace the thermal element of any Partlow control instantly, right at the job site, without recalibrating, fitting or factory adjustment.

Whatever the process or application, you'll find a Partlow temperature control to fit it dependably, economically, *precisely*. Mail coupon today.

See Partlow Section in Chemical Engineering Catalog

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TEMPERATURE CONTROLS

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Please send condensed Catalog of Partlow temperature controls and allied equipment for industrial heating and refrigeration.

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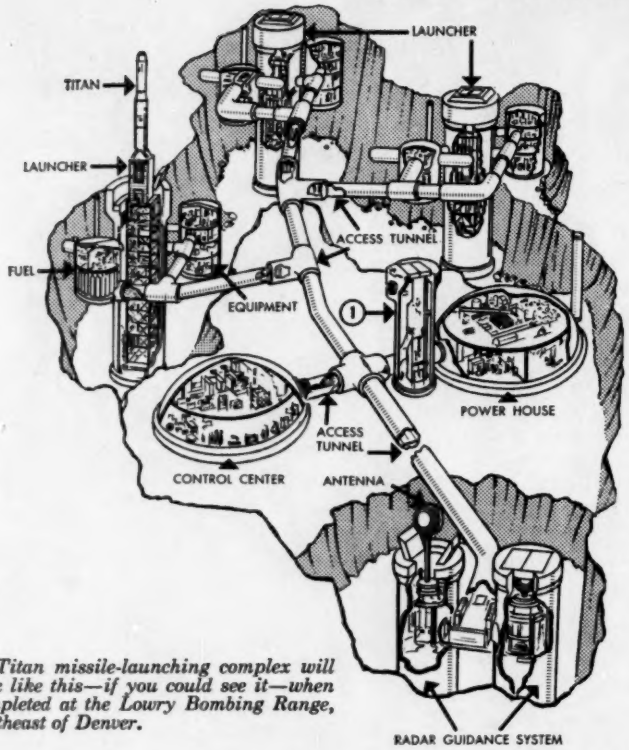
PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

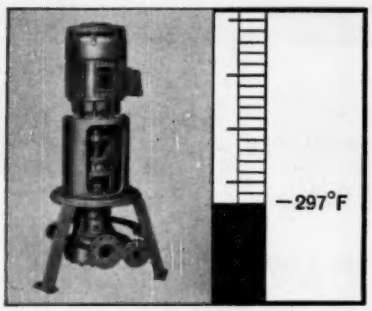
Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units —from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

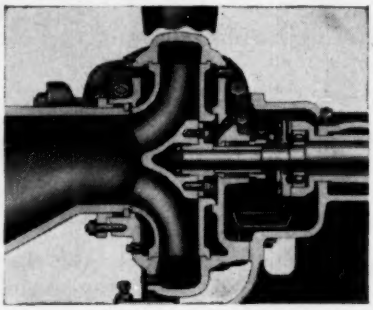


How to pump cryogens

One company pumps liquid oxygen at −297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogens raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.



Cotton pickin' pump

Nine Model 3135s pump cotton linter stock *in a smooth flow* for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.

Now... small-capacity pump for chemicals and slurries

Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. CE-31, Seneca Falls, New York.

GOULDS PUMPS

It takes 64 gallons of H_2O to make one gallon of H_2SO_4

To make 200 gallons of sulfuric acid you need approximately 12,500 gallons of water.

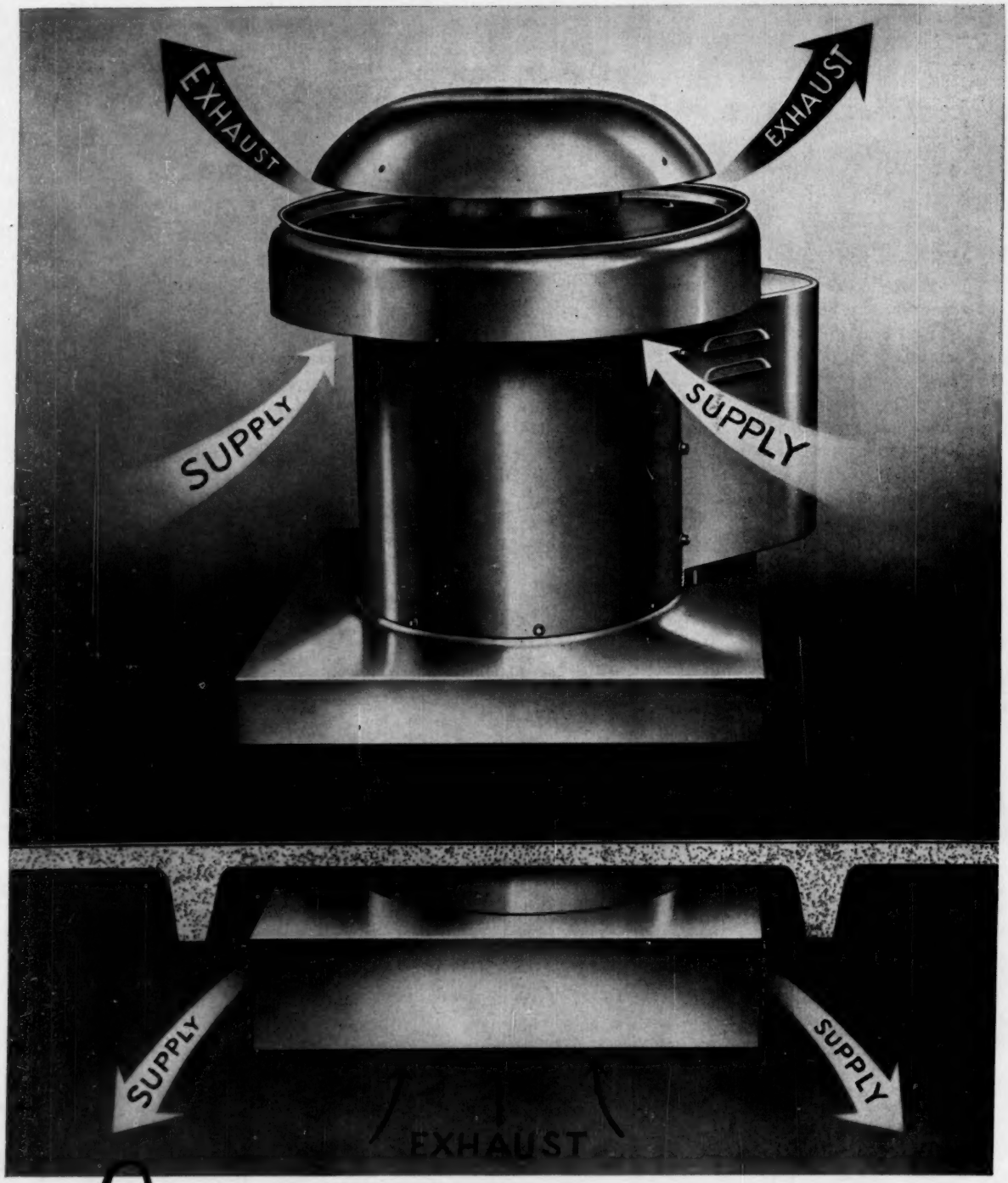
It would take just *two minutes* for a twelve-inch Goulds Fig. 3405 to supply it. This medium-size pump provides giant-size capacity: 6400 gallons per minute!

And to keep water flowing, you stock only a minimum of spare parts. Just three groups of parts fit thirty-three sizes of the 3405. All parts are interchangeable except casings, casing covers and impellers!

That means that for every three to five pumps of a given group size, you stock just one shaft, one set of bearings, sleeves, mechanical seals or packing. You can cut inventories as much as ninety-one percent, yet be fully covered for emergencies.

Heads go up to 425 feet. For more data, write to Goulds Pumps, Inc., Dept. C-2, Seneca Falls, N. Y., for Bulletin 721.6.

GOULDS PUMPS



One impeller does it

You get both air supply and exhaust simultaneously with the new Clarage TWINALATOR*. Unique, superior dual function air handling for all types of buildings. Definite money-saving advantages: Requires only one opening, one motor, one drive, one starter. No make-up air unit necessary. Applications unlimited — well adapted to closed or semi-closed systems. Can be provided with heating coils and filters. Write today for Bulletin 552. CLARAGE FAN COMPANY, Kalamazoo, Michigan. Clarage sales engineering offices are located in all principal cities.

*Patented Trademark

An announcement of special importance

to users of phosphoric acid:

phospholeum

new superconcentrated 105% phosphoric acid offers you these important advantages:

- versatile natural desiccant (*only 24% H_2O*); works fine in reactions where less concentrated phosphoric, containing appreciable water, is unsuitable;
- excellent sequestrant for trace minerals;
- lively catalyst or dehydrator in organic synthesis;
- regenerates aluminum bright dips—without metallic cation contamination; gives better control because of low water content;
- can be supercooled for days *without crystallization*;
- less corrosive, easier to handle—dilutes readily, too;
- *immediately available*, PHOSPHOLEUM superconcentrate can shave $$$ off your freight and storage expenses.

MONSANTO CHEMICAL COMPANY
Inorganic Chemicals Division
St. Louis 66, Missouri

Please send me a copy of TDS I-210 . . . containing complete technical information on PHOSPHOLEUM.

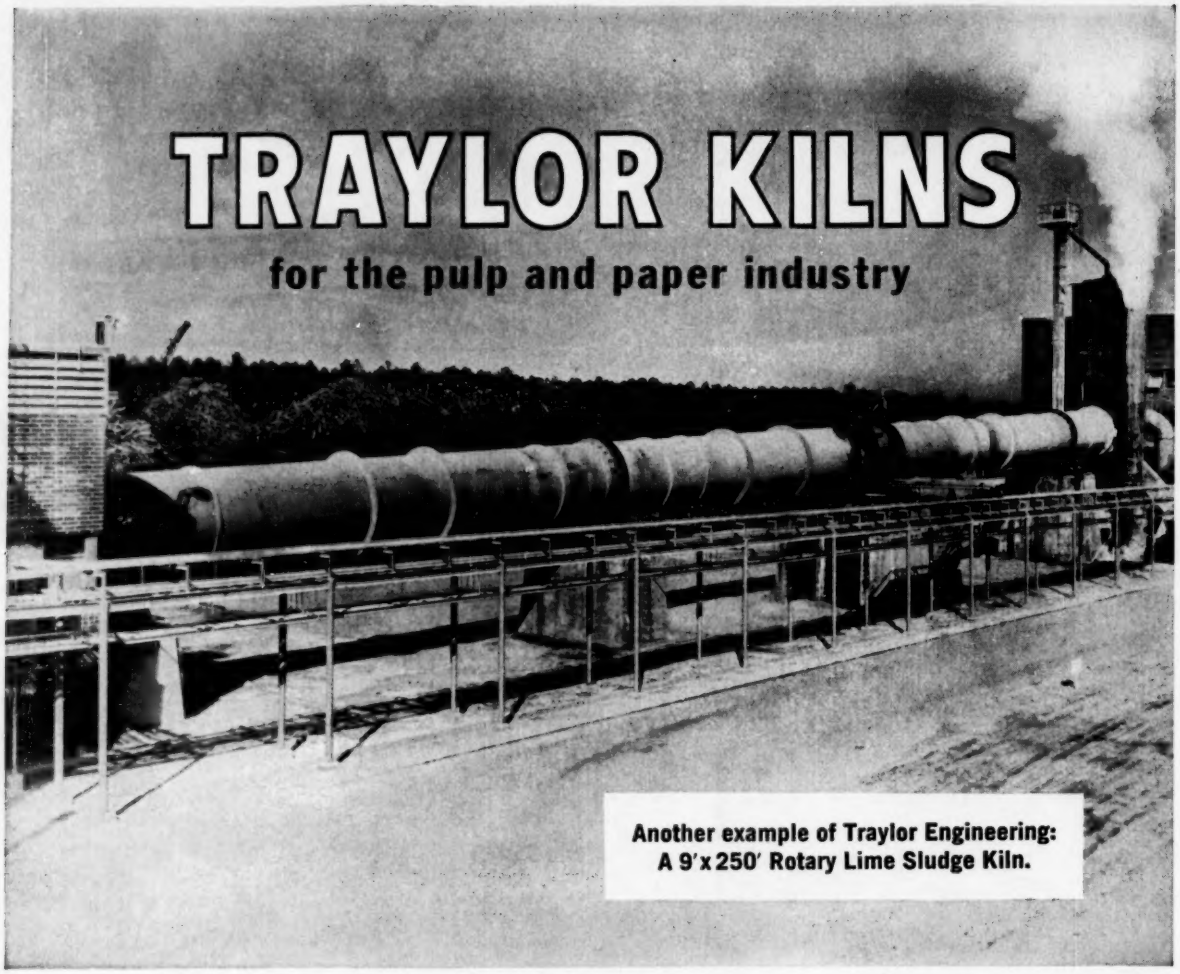
Name _____

Company _____

Street _____

City _____ *Zone* _____ *State* _____

PHOSPHOLEUM: Monsanto trademark



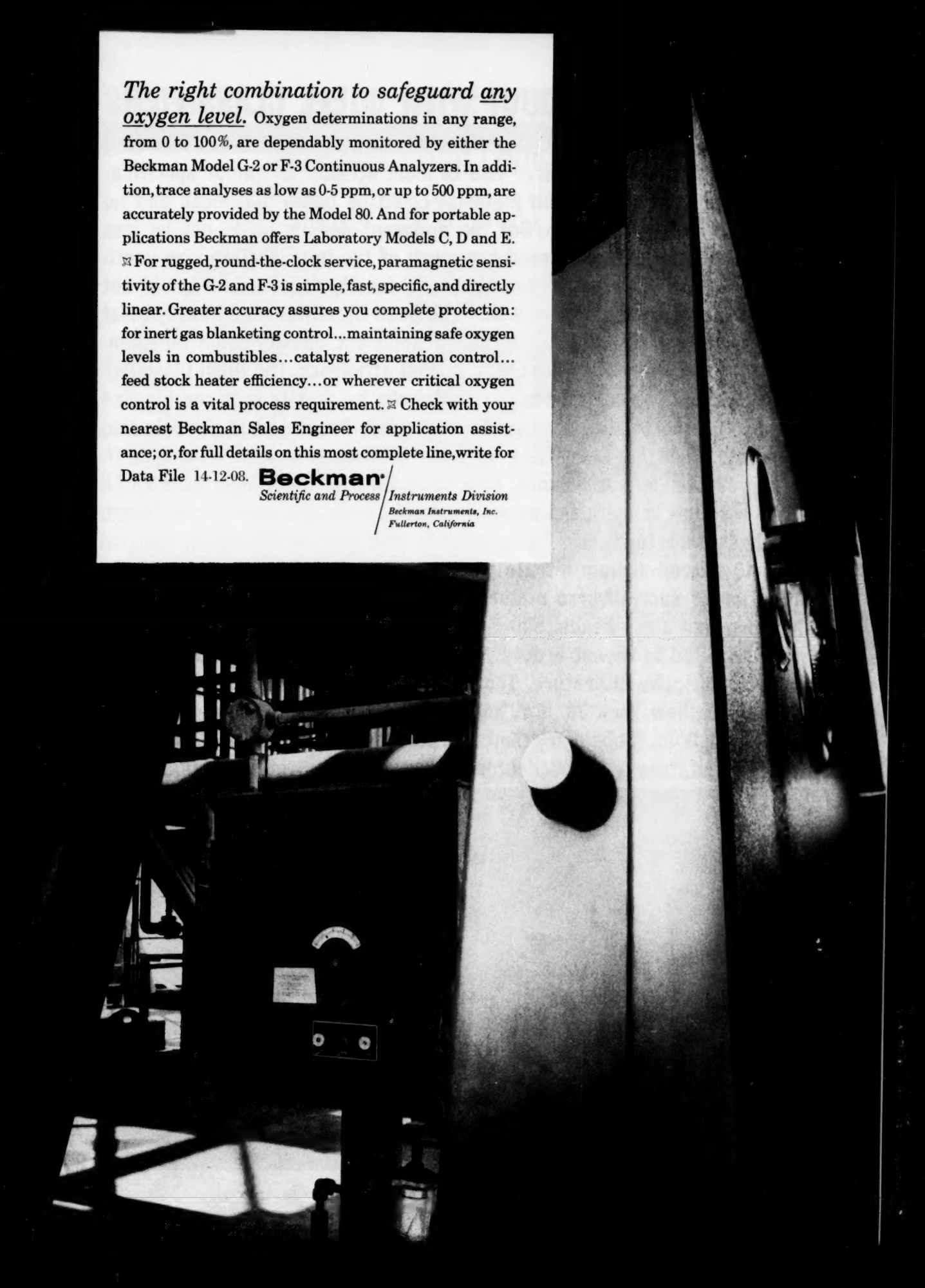
One of the most important advantages of Traylor Lime Sludge Kilns in pulp mill operations is their money-saving efficiency in recovering lime for reuse over and over again. This, plus Traylor's unexcelled heat recovery systems and thorough, experienced attention to engineering details, produces kiln installations that are notable for continuous service.

Write for Bulletin TKB-3 on Heat Recovery Systems, or Bulletin No. 1115 on Traylor Kiln installations.

See Chemical Engineering Catalog for Details and Specifications

TRAYLOR ENGINEERING & MANUFACTURING
DIVISION OF FULLER COMPANY
1551 MILL STREET, ALLENTOWN, PA.
Sales Offices: New York—Chicago—San Francisco
Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P.Q.

TEA-0



The right combination to safeguard any oxygen level. Oxygen determinations in any range, from 0 to 100%, are dependably monitored by either the Beckman Model G-2 or F-3 Continuous Analyzers. In addition, trace analyses as low as 0-5 ppm, or up to 500 ppm, are accurately provided by the Model 80. And for portable applications Beckman offers Laboratory Models C, D and E. ⌘ For rugged, round-the-clock service, paramagnetic sensitivity of the G-2 and F-3 is simple, fast, specific, and directly linear. Greater accuracy assures you complete protection: for inert gas blanketing control...maintaining safe oxygen levels in combustibles...catalyst regeneration control... feed stock heater efficiency...or wherever critical oxygen control is a vital process requirement. ⌘ Check with your nearest Beckman Sales Engineer for application assistance; or, for full details on this most complete line, write for Data File 14-12-08.

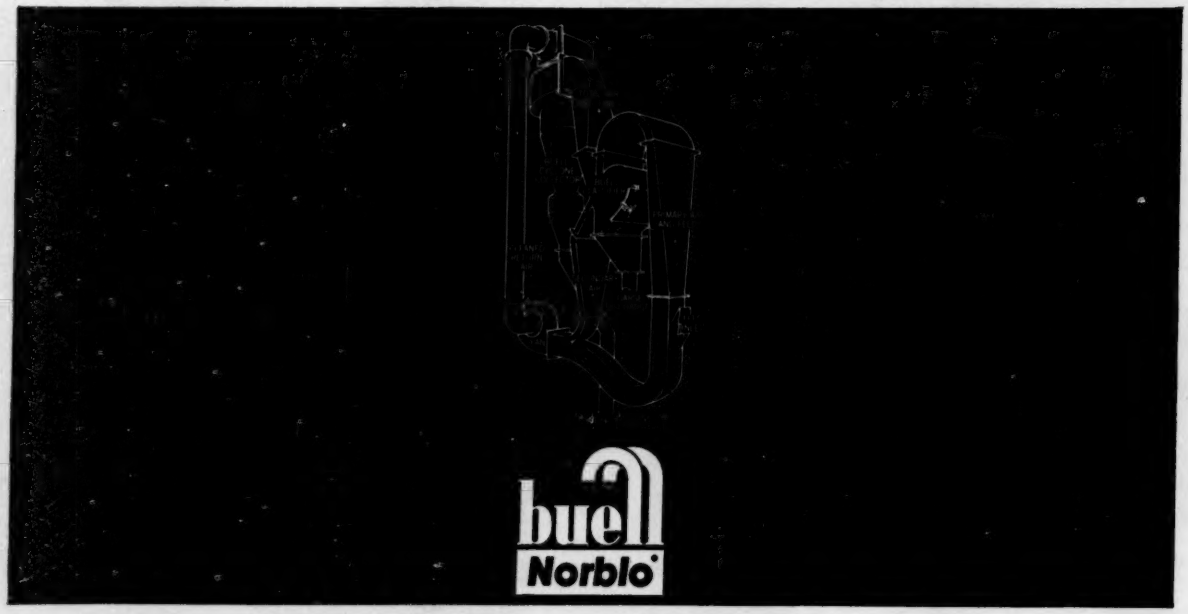
Beckman

Scientific and Process Instruments Division

Beckman Instruments, Inc.
Fullerton, California

IMPROVE YOUR PRODUCT WITH BUELL CLASSIFIERS

A sodium phosphate manufacturer had to meet stricter customer specifications. No more than 15% of the material could be below 100 mesh and no more than 1% below 270 mesh. But the apparent density could not be less than 0.98. If the classifier removed too much of the intermediate size particles from the finished product, the apparent density requirement could not be met. ■ Laboratory tests proved that the Buell Classifier could easily meet the mesh requirements, and the required apparent density could be maintained if the classification was at 95% overall efficiency. The Buell Classifier simply discharged the coarse sodium phosphate by gravity into one bin and carried the fine material by air to a second bin. ■ Despite rigid particle-size requirements, Buell Air Classifying Systems operate to critical size specification at well over 90% efficiency. High capacities let them keep up with all mills. And with low velocity and no moving parts, wear is almost non-existent. ■ Buell Classifiers today are being used in iron ore beneficiation, removal of minus 10 micron sodium nitrate particles, dedusting of soda ash and the classification of such diverse materials as phosphate rock, silicon carbide, uranium ore and glass beads. Many installations have proved so successful that they have led to repeat orders. Why not send us your specific problem? Write for descriptive literature. The Buell Engineering Co., Inc., Dept.12-C 123 William St., New York 38, N.Y. Northern Blower Division, 6411 Barberton Ave., Cleveland, Ohio. (Subsidiary: Ambuco, Ltd., London, England) ■ Cyclones • Electric Precipitators • Bag Collectors • Combination Systems • Classifiers



SEL-REX RECTIFIERS HELP PUT GOOD LOOKS AND DEPENDABILITY INTO BUSY TALON ZIPPERS!

Sadler's Wells Ballet, now the Royal Ballet, as it appeared on NBC-TV

Ballerinas know, as do women everywhere, that confidence is difficult to measure. For, it often rests on little things—from a dab of makeup to the dependability of a zipper. Engineers know it too... knowledge acquired from years of strict attention to detail. Typical is the confidence of Talon engineers, men who build amazing dependability into every Talon fastener.

Talon, Inc. engineers have chosen Sel-Rex Selenium Rectifiers and Sel-Rex Remote Control Units to supply and to control the D.C. needed in their metal finishing departments. These Sel-Rex units provide the power for nickel plating, copper plating and zinc barrel plating —where superior quality depends upon precise current and its control.

According to Robert E. Hammer, Manager Plant 7, Talon, Inc., Meadville, Pa., "We rely on these units not only for minimum maintenance requirements but also for the exacting power control necessary to maintain our high quality standards."

If a dependable source of D.C. is among *your* plant requirements, join the thousands of experienced and *confident* engineers who have chosen Sel-Rex Rectifiers as their source of trouble-free power.

Complete Semi-Conductor Power Conversion Equipment and Systems for any AC to DC Application

Send for Free "GUIDE" to Industrial Rectifier Equipment

MEAKER 1899

THE MEAKER COMPANY

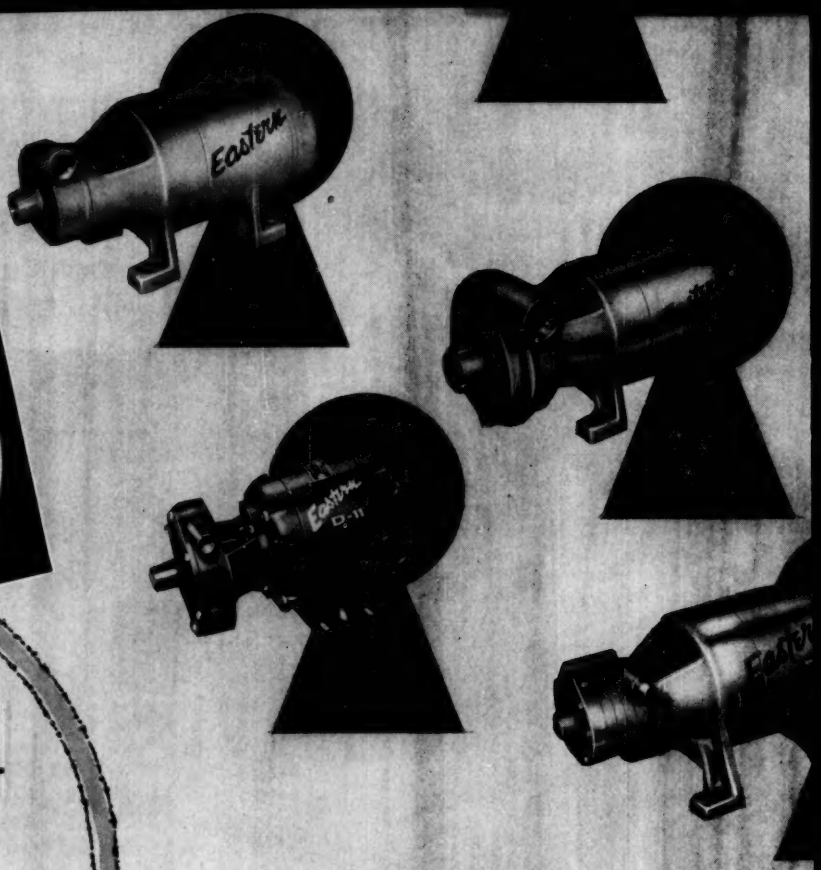
SUBSIDIARY OF SEL-REX CORPORATION

Nutley 10, New Jersey

Factories and offices Chicago 50, Ill., Los Angeles, Cal. and Nutley 10, N. J.

Representatives in principal cities.

Eastern



your key to the perfect choice of CENTRIFUGAL PUMPS

A new catalog opens wide the doors to designers of process equipment — tells all you need to know in terms of engineering data, performance charts, seals, metals, mountings!

If you need centrifugal pumps with these characteristics, this reference book is for you:

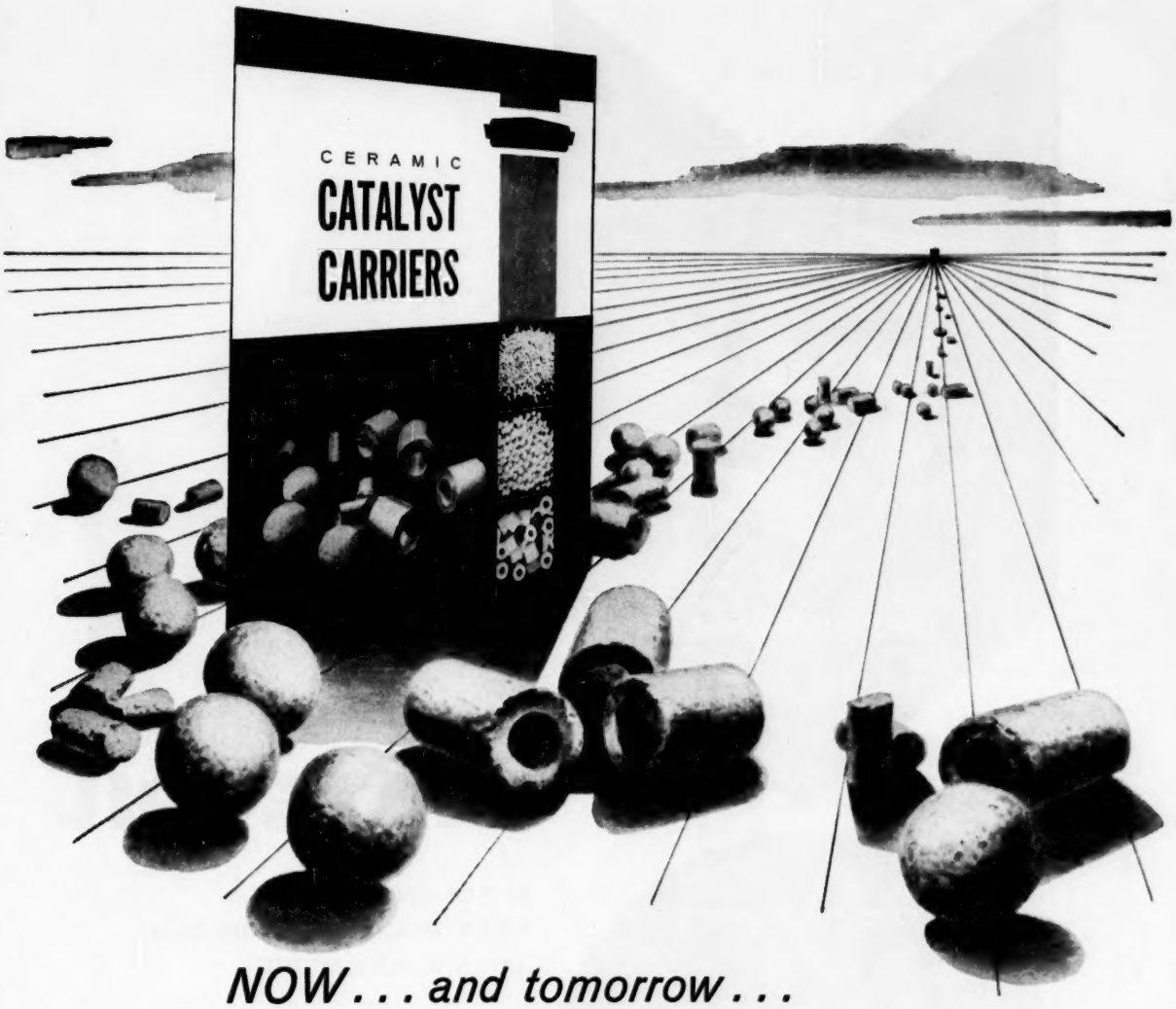
- PRESSURES: to 21 psi in single stage pumps; to 70 psi in multi-stage types.
- FLOWS: capacities to 70 gpm in single-stage pumps, to 10 gpm for multi-stage models.
- MOTORS: standard motors for 115/230 volts 60 cycles 1 phase (other electrical characteristics available). Power range from ⅛ to 1½ H.P.
- ENCLOSURES: drip-proof, totally enclosed, and explosion-proof ballbearing frames.
- DRIVES: Space-saving close coupled pumps most rugged and popular. Pedestal mounted arrangement without motor available as alternate for belt or coupling drive.
- SEALS: a variety of rotary seals and stuffing boxes, to fit every application.
- METALS: your option of cast iron, bronze, stainless steel, Monel, Cast Iron, Hastelloy "C".
- INSTALLATIONS: a wide range of transfer, recirculation, feed, boost and filter-pumping applications.

All told, 50 different models are described in full — and you get a wealth of technical data as well. Write for new catalog 130 now!

EASTERN INDUSTRIES PUMP DIVISION

EASTERN INDUSTRIES, INCORPORATED

100 SKIFF STREET, HAMDEN, CONN.
WEST COAST OFFICE 4203 Spencer St., Torrance, Calif.



NOW . . . and tomorrow . . .

choose NORTON Ceramic Catalyst Carriers

In columns and reactors throughout the chemical and petrochemical industries, NORTON Ceramic Catalyst Carriers are helping processors to improve catalyst activity and life, lower catalyst costs, get optimum yields from reactions.

It's *consistent* high performance too, because *every* NORTON Carrier is uniform in *any* quantity from lot to lot. Size, weight, porosity, and purity are held to close tolerances. Duplication of specifications is assured.

Today, probably the most widely-used NORTON Carrier is alumina . . . in ring, sphere, and pellet form and as granules and powder. However, as new feedstocks are developed, and more demanding physical, chemical, and thermal conditions are encountered, new NORTON Carriers will be ready to meet catalysis specifications. For example, various materials are now available in experimental quantities as spheres, rings and pellets . . . in alumina, magnesia-alumina spinel, fused magnesium oxide, silica, zircon, zirconia and silicon carbide. These NORTON developments offer porosities ranging from 4% to 65%; surface areas from less than 1 to $70 m^2$/gram (BET method).

Also readily available is the technical assistance of the Norton Man. Through him, chemical engineers can draw upon the wealth of research and engineering data compiled over the years by the NORTON COMPANY. He is well qualified to help *you* meet catalyst carrier specifications exactly . . . efficiently . . . economically.

NORTON Carriers are described in detail in the Bulletin, "Keys to Better Catalysis". For your copy, or for technical assistance, write NORTON COMPANY, Refractories Division, 502 New Bond Street, Worcester 6, Massachusetts.

REFRACTORIES

Engineered . . . By . . . Prescribed

***75 years of . . .* Making better products . . . to make your products better**

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

PLATECOIL®

IS SOLVING MORE HEAT TRANSFER PROBLEMS THAN EVER BEFORE

New manufacturing techniques and facilities now make available a wider variety of shapes, forms and styles of TRANTER PLATECOIL—applicable to more tank and process heating and cooling and special heat transfer requirements than ever before.

A TRANTER PLATECOIL consists of two metal sheets, (one or both of which are embossed), spot welded and seam welded together to form channels for heating or cooling media. In addition to standard styles, PLATECOIL offers the design and development of specially formed PLATECOIL to meet specific application requirements.

Thousands of PLATECOIL applications to the heat transfer problems of the processing and manufacturing industries have saved users time and money on engineering, fabricating, installation and maintenance . . . out-performing other types of heat transfer equipment.

"Standard" Style 90 PLATECOIL with exclusive "MULTI-ZONE" design, for optimum steam distribution. Serpentine styles for cooling also available as standard.

Ask for PLATECOIL® BULLETIN P61.

Tranter Manufacturing, inc.

LANSING 9, MICHIGAN

PLATECOIL® DIVISION

CENTRIFUGAL SKILL AT WORK

SHARPLES SUPER CONEJECTOR...

4 Sizes To Meet Every Need

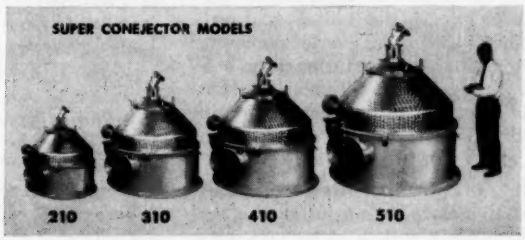
Only with the Sharples Super Conejector do the chemical and food industries have a choice of four sizes for the effective, economical separation of process feeds containing high concentrations of medium-to-coarse crystalline solids, as well as fibrous pulps.

Actually, the four sizes of Super Conejector are today setting the pace for efficient, high production processing. They span the wide industry requirements for production, research and pilot plant operations.

The Sharples Super Conejector applies three continuous dynamic forces — Separating . . . Filtering . . . Metering — to the material being processed. This most efficient application of centrifugal force assures maximum dryness of solids at a minimum consumption of power.

Versatility is built into the Super Conejector with many variables available to meet individual requirements. Processing flexibility is achieved simply by changing these variables and varying the rotational speed.

The Super Conejector is another example of Sharples Centrifugal Skill at Work. Get the full story of this new concept in processing—learn how it can be applied to your special need. Send for your free copy of Bulletin 1288 — "Sharples Super Conejector: Setting The Pace For Efficient, High Production Processing."



You Made Sharples *First!*

THE SHARPLES CORPORATION

Centrifugal and Process Engineers

2300 WESTMORELAND STREET / PHILADELPHIA 40, PENNSYLVANIA

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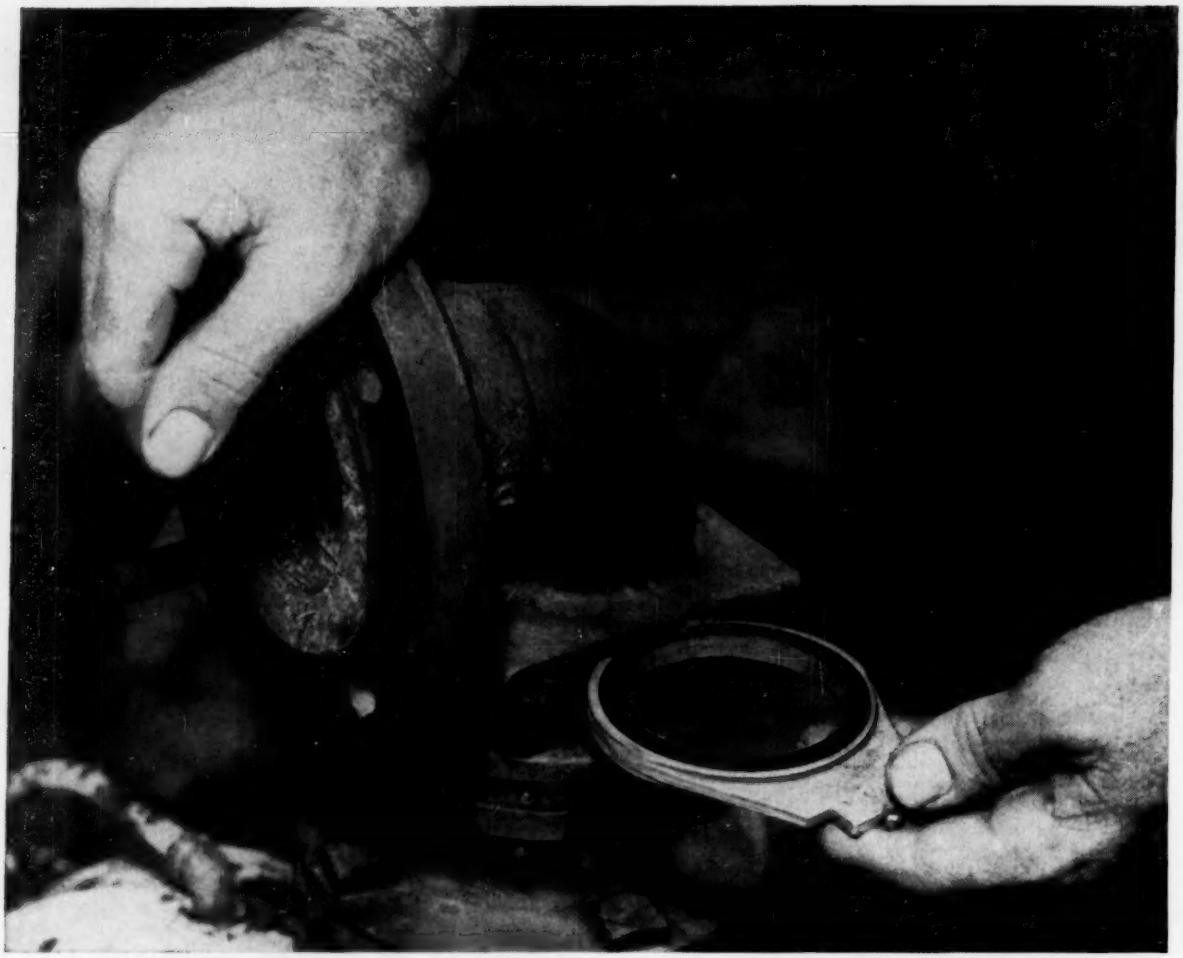


SEALING AGAINST SOLVENTS, CRUDE OIL, CRESOL, GASOLINE...

VITON® PACKINGS UNHARMED BY 2 YEARS' FLUID EXPOSURE

With the reputation that VITON synthetic rubber has built for heat resistance (serviceable at 450° F. and up), engineers sometimes overlook the value of its outstanding performance in contact with fuels, oils, solvents and chemicals. Here is an application* where fluid resistance was the *only* problem ... and VITON the only answer.

In 1957, General American Transportation Corporation installed a new fluid loading system at its tank farm in Galena Park, Texas. Swivel joints on the system required packings made of rubber. The problem: what rubber could handle crude oil, solvents, gasolines, cresol and sodium cresylate—to mention just a few of the fluids in storage? The answer: Du Pont VITON.

For well over two years, packings made of VITON, Du Pont's new fluoroelastomer, have been used in General American's tank car loading system to handle more than 80 different fluids. A recent visual inspection revealed no swelling, no deterioration and not a trace of product leakage. What's more, every packing originally installed (72 in all) is still in service.

• • •

Outstanding resistance to oils, fuels, solvents and chemicals, as well as to elevated temperatures, has helped VITON improve performance of refinery valves, heat exchangers, pumps and a wide range of industrial equipment. Write for specific data on the heat and fluid resistance of this new elastomer. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CE-3, Wilmington 98, Delaware.

*This case history from the ELASTOMERS NOTEBOOK—subscription free on request.

PROPERTIES OF VITON

Hardness Range	60-95 Shore A
Tensile Strength	Over 2,000 psi.
Temperature Range	—40° F. to 600° F.
Chemical Resistance	Excellent
Oil Resistance	Excellent
Compression Set Resistance	Very Good
Ozone Resistance	Outstanding
Flame Resistance	Good
Sunlight and Weather Resistance	Very Good
Abrasion Resistance	Good

DU PONT REG. U. S. PAT. OFF.

VITON®
SYNTHETIC RUBBER

Better Things for Better Living ... *through Chemistry*

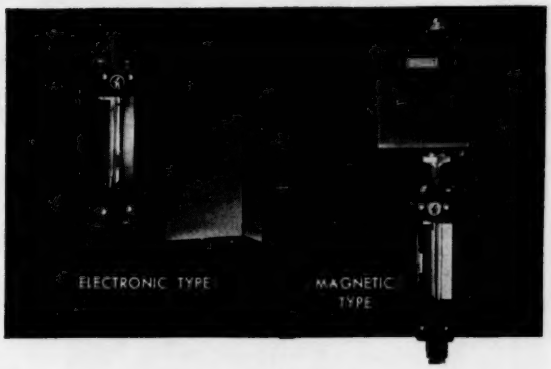
SK Gear Pumps
HANDLE MANY MATERIALS

Engineers in all types of plants are using SK Gear Pumps to handle materials ranging from kerosene to glue. Time after time these pumps have replaced other types in critical applications. In case after case they have solved costly maintenance or poor performance problems. And, what they have done for others they can also do for you. Why not tell us about your application. We'll be glad to help.

For details—ask for Bulletin G-1

SK Alarm Rotameters
SIGNAL ABNORMAL FLOW RATES

SK Alarm Rotameters accurately measure fluid rate of flow—activate a light or alarm device, start or stop a pump, motor, control unit *in case of abnormal flows.* They are accurate, economical, dependable.

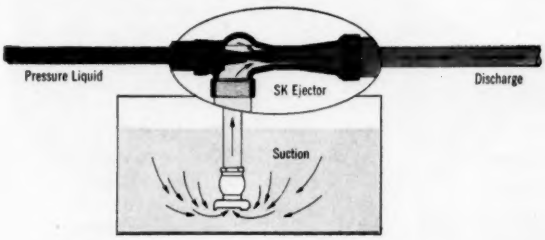


For details—ask for Bulletin 18A.

SK Liquid Jet Ejectors
PUMP AND MIX SIMULTANEOUSLY

SK Liquid Jet Ejectors utilize the kinetic energy of a liquid under pressure to entrain, mix, and pump liquids or handle slurries and granular solids. Uses vary from pumping out a sump to mixing chemicals in proper proportions.

Some user benefits: (1) *economy*—a 2-inch, bronze unit costs only $51.00; (2) *maintenance-free service*—simple construction and lack of moving parts makes supervision unnecessary; (3) *availability*—stocked in popular sizes in Pennsylvania, Texas, California; (4) *adaptability*—made and stocked in cast iron, bronze, stainless steel, asbestos-filled resin, PYREX brand tubing, and PVC.



For details—ask for Bulletin 2M

SK Steam Jet Vacuum Pumps
PRODUCE HIGH VACUUM ECONOMICALLY

SK Vacuum Pumps utilize a high velocity jet of steam, issuing from a nozzle, to provide low and high vacuum service in connection with numerous process applications. A single-stage unit, as shown, will provide suction pressures from atmosphere to 1.5 in. Hg abs. A five-stage unit will provide suction pressures from 0.25 mm Hg abs to 25 microns Hg abs.

Simple in design, with no moving parts, SK Vacuum Pumps are low in cost, economical to operate. They are available in popular sizes in various materials from stock in Pennsylvania, Texas, California.

For details—ask for Bulletin 5E

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin G-1.

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2217 State Road, Cornwells Heights, Bucks County, Pa.
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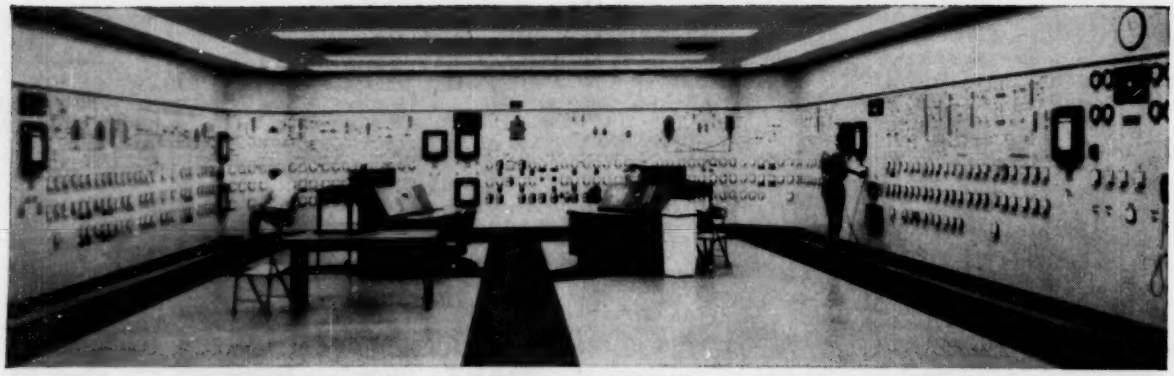
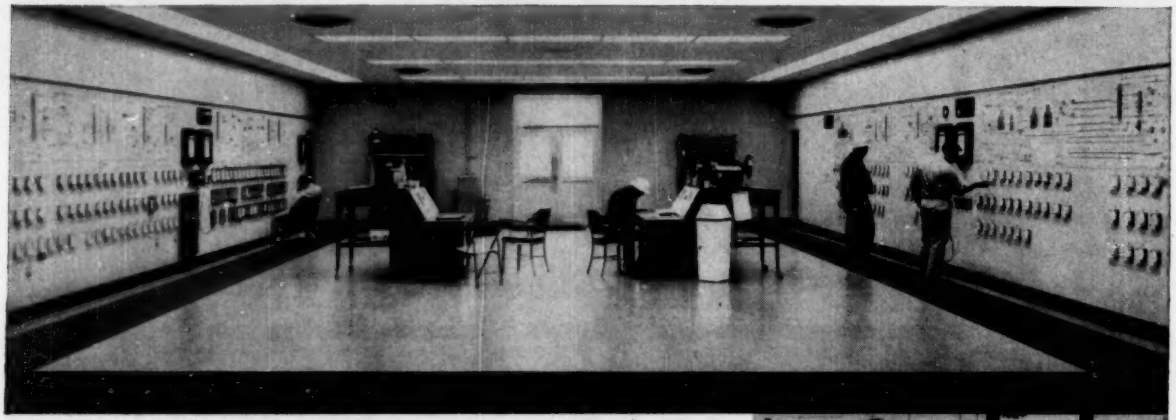
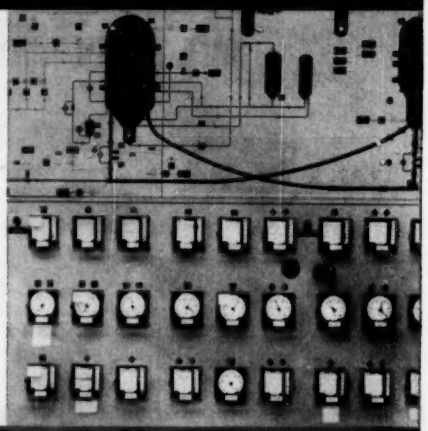




Bristol Metagraphic recorders and indicators occupy lower three rows on panel (shown in two photos above). Enlarged panel section is shown below, right.



"NERVE CENTER" AT BIG NEW TEXACO PLANT INCLUDES BRISTOL METAGRAPHICS

This model central control room is the nerve center for a vast petroleum processing complex. It's located in the new Puget Sound Works of Texaco Inc., at Anacortes, Washington.

A key feature of the control system is a battery of several hundred Bristol Metagraphic pneumatic recorders, indicators, and controllers (lower three instrument rows on panel). The new plant produces motor gasolines, jet fuels, liquified petroleum gases (LPG), diesel fuel, furnace oil, and heavy fuel oil. Crude oil capacity is 45,000 barrels per calendar day. o.7

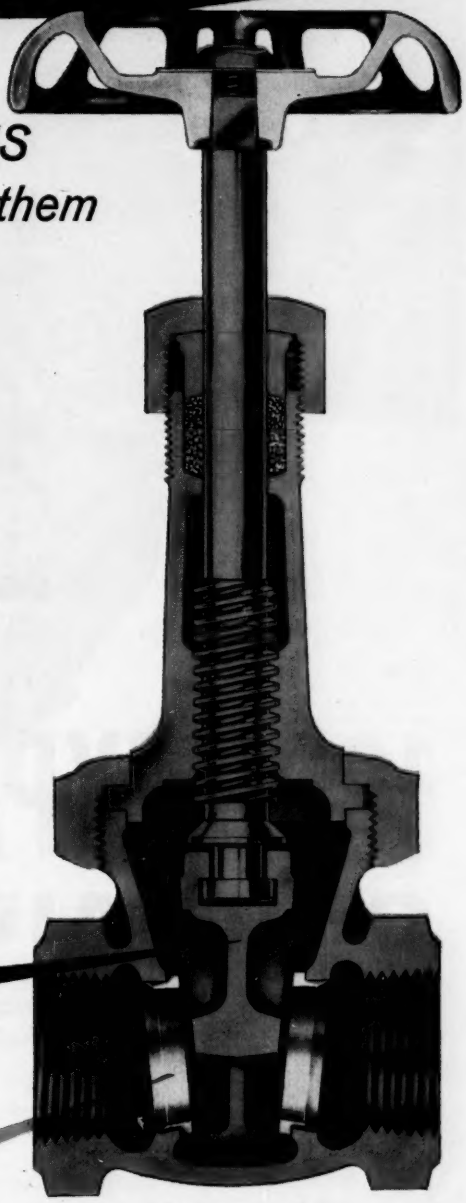
BRISTOL ... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

This is just one of hundreds of installations of Bristol Metagraphic instruments in use today in processing plants throughout the country. These compact instruments are ideal for graphic panel use, or where true "plug-in" versatility is necessary to insure maximum control system reliability and continuity of service. We'll be glad to send you the complete Metagraphic story. Write: The Bristol Company, 109 Bristol Road, Waterbury 20, Conn.

It's Horse Sense ...

Why Chance Leaks in Seat Rings



Get Monel Seat BRONZE GATES made the way JENKINS makes them

It's plain horse sense that you had better have the Monel seat rings EXPANDED (ROLLED) into the valve body if you want them to stay tight and leak-proof.

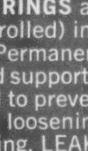
More horse sense . . . there's nothing valuable lost through having seat rings that can't be replaced by a regular maintenance man . . . **IF** the bronze or nickel alloy wedge has a lower degree of hardness than the heat-treated Monel seat rings. *(The way Jenkins makes them)* Then, the wedge takes the wear and seat rings are relatively unaffected.

Obviously, there's no faster, simpler or cheaper way to renew tightness and efficiency than to slip on a new wedge. And that, plus renewal of packing as needed, is all you need do to assure good performance from Jenkins Monel Seat Bronze Gates for as long as you'll need to care. Good service for scores of years is common.

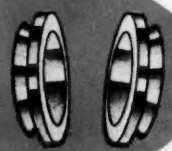
Long, low-cost life also results from greater-than-ever-needed strength in every part of these valves. The records of millions of Jenkins Bronze Gates show you get full protection against all the stresses encountered in use.

Your local Jenkins Distributor will quickly supply your needs from a wide variety of Jenkins Bronze Gates. For information about these valves, write for folder No. 181-C. Jenkins Bros., 100 Park Ave., New York 17.

WEDGE is less hard than seat rings. Wear affects this easily replaceable part . . . NOT seat rings



SEAT RINGS are expanded (rolled) into body. Permanent, all-around support is essential to prevent deforming, loosening, shifting, LEAKS



JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

JENKINS SINCE 1864

Jenkins Bros.

Sold Through Leading Distributors Everywhere

1800 EXPANSION JOINTS OF STAINLESS STEEL

Air Force Titan missile bases require many miles of stainless steel LOX piping. To protect these piping complexes from thermal changes and shock conditions, special stainless steel expansion joints —1800 of them—were required.

Adsco built these special expansion joints, taking them carefully through design, forming, welding, and assembly. The expansion joints were cycle-tested with liquid nitrogen at -297° F. and cleaned. The Corps of Engineers inspected each one under black light and each joint was hermetically-sealed. System cleanliness limits were 25 parts per million —150 micron particles.

Knowledge and experience such as this could be of help to you in your expansion joint work. Call on Adsco!

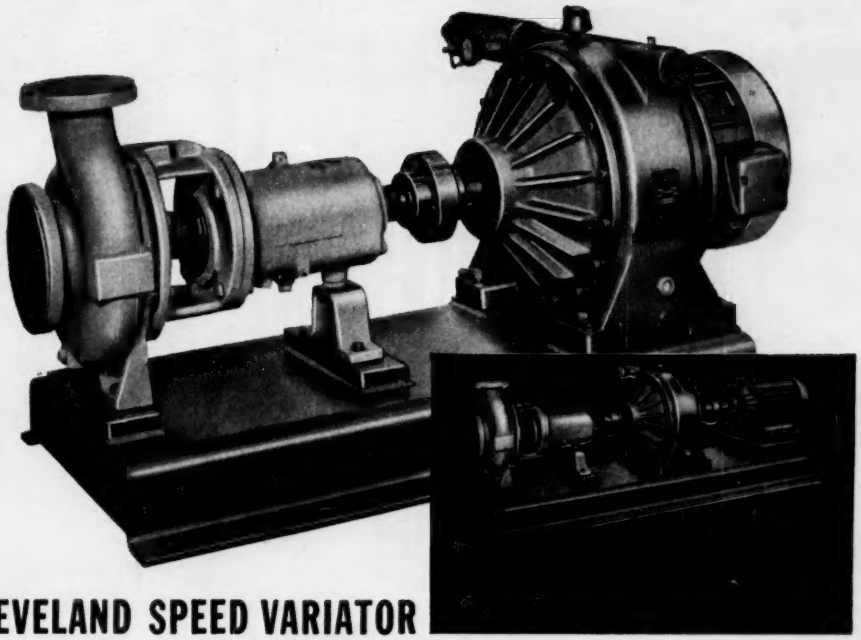
ADSCO DIVISION
20 MILBURN STREET
BUFFALO 12, NEW YORK

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

for exacting chemical process operations...

- Screw Feeders
- Liquid Phase Pelletizers
- Metering Pumps
- Plastic Blending Machines
- Cylindrical Dryers
- Rotary Feeder Drives
- Agitator Drives
- Conveyors



CUSTOM MADE CLEVELAND SPEED VARIATOR BED PLATE ASSEMBLIES GIVE PRECISION CONTROL OF INFINITELY VARIABLE SPEED OUTPUT

Now, for the first time Cleveland's *New* Motorized Speed Variator may be engineered into compact, pre-tested drive arrangements for powering your driven equipment in non-hazardous locations. These assemblies are accurately pre-aligned at the factory—require little maintenance, only periodic oil changes.

HERE'S THE COMPLETE STORY:

- Requires only slightly more space than an equally rated standard electric motor
- Provides variable output speeds over 9:1 and 6:1 ranges
- A complete line featuring 5 sizes from ⅓ to 15 HP
- Integral "pancake" style AC radial air gap motors conforming to NEMA design "B" specification
- Provides speed holding accuracy up to 0.1% with uniform loading
- Output speeds smoothly and easily adjusted while operating under load

These versatile mechanical-type drive units are especially applicable for chemical blending operations where it's important to hold fixed speeds. They can be run at definite speed settings for extended periods without localized wear of running parts or freeze-up of speed changing mechanism.

Variator is a true torque converter—provides high torque at low speeds for constant HP applications—gives traction even during periods of extreme overloading.

For complete engineering information on the *New* Cleveland Motorized Speed Variator, write for free, illustrated bulletin Number 275 or contact your Cleveland representative today.

CONTROL VERSATILITY

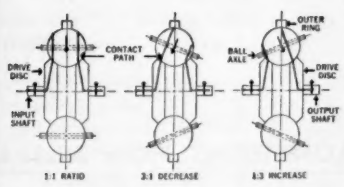
For manual operation, a hand wheel is mounted on an extension of the control worm and equipped with a turns counter to indicate relative speed settings

For electrical remote - controlled operation, a small single-phase motor drives the worm through chain and sprockets, or enclosed gearing

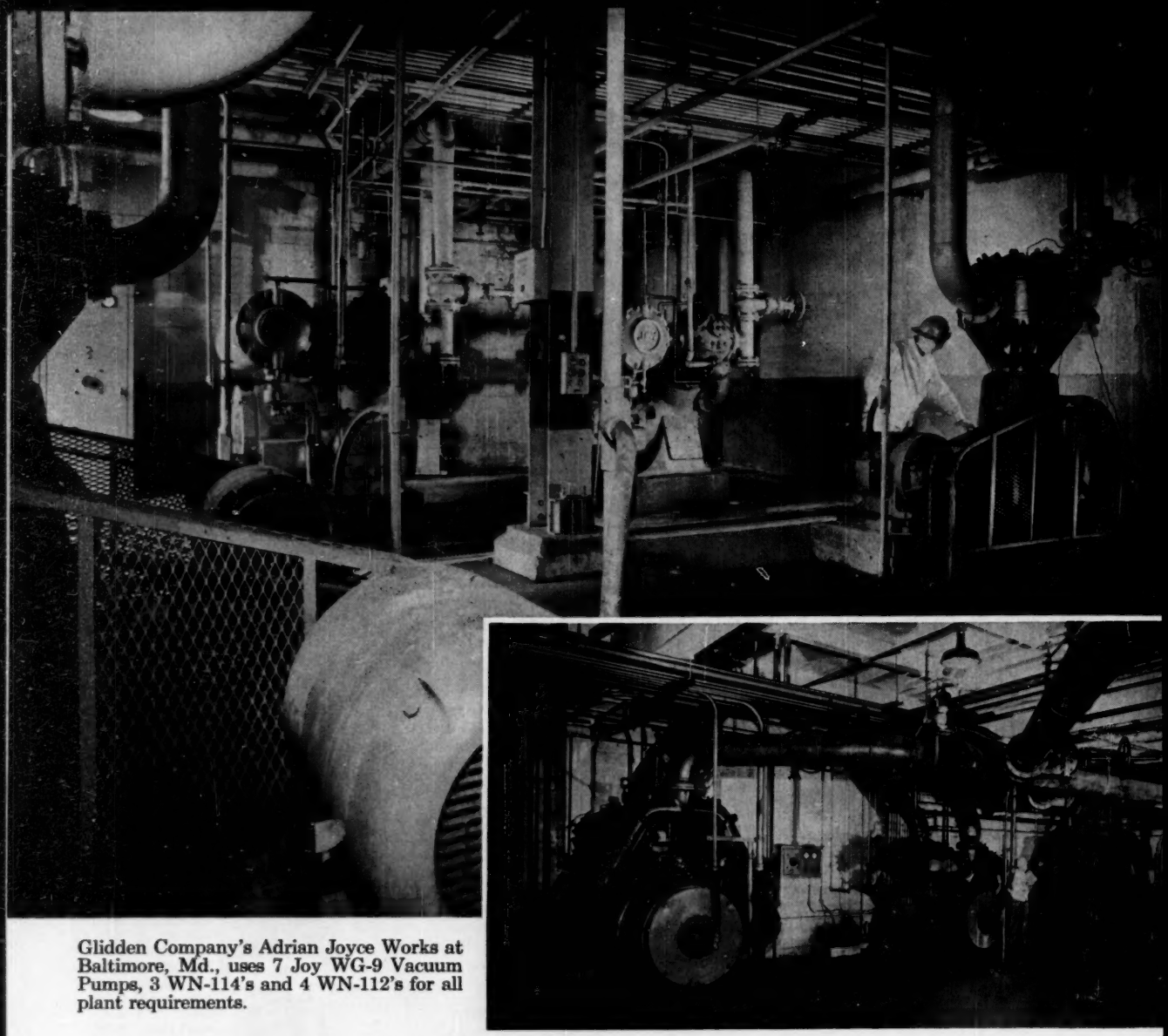
This pneumatic operator accurately positions the control worm in direct relationship to a 3 to 15-pound air signal

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3275 East 80th Street • Cleveland 4, Ohio

CLEVELAND VARIATOR



How The Speed Variator Works
Power is transmitted through input shaft to a beveled drive disc in contact with axle-mounted alloy steel drive balls. Input shaft rotation causes balls to rotate about their axles. Power is then transmitted from all rotating balls to output shaft by similar ball-disc contact on the output side. Output speed is determined by relative lengths of contact paths on input and output sides of the balls. By tilting both axles and balls, relative lengths of the two contact paths are varied to give increasing or decreasing ratios as shown on the sketches.



Glidden Company's Adrian Joyce Works at Baltimore, Md., uses 7 Joy WG-9 Vacuum Pumps, 3 WN-114's and 4 WN-112's for all plant requirements.

FOURTEEN JOY COMPRESSORS SUPPLY VACUUM, PLANT AND PROCESS AIR AT GLIDDEN'S ADRIAN JOYCE WORKS

The Glidden Company's modern Adrian Joyce Works relies on fourteen Joy compressors to provide all of the air requirements, ranging from 25" vacuum service to 30 pound process air and 100 pound plant air. The plant converts ilmenite to titanium dioxide by the sulfate process, which involves the use of sulphuric acid as a reducing agent. During the three years the plant has been operating, all fourteen Joy machines have stayed on the line with a minimum of downtime for maintenance.

Joy compressors are built for the rugged duty typical of chemical plants. Heavy casings and conservative rod loadings enable them to easily handle air and gases for extended periods of continuous service. Joy can provide reciprocating machines in standard or oil-free constructions, axial and centrifugal compressors in sizes from 15 to 15,000 hp. Consult your Joy representative whenever you need a compressor. For complete information on the Joy line, write for Bulletin 2561-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

HOKE **Flow Sheet** 4

HOKE REPORTS ON FLUID CONTROL

HOW TO SWITCH PRESSURES IN MID-STREAM

PRESSURE BY THE POUND . . . no matter how thin you slice it!

One trouble with doing something better is that it's hard to stop. This time, we've come up with a new line of pressure regulators. We made them for the technically oriented who have developed high standards and for the penurious purchaser who wants something for (almost) nothing.

One, tagged as the 680 Series, is a highly stable single stage regulator with something for just about everyone. The core of this regulator is its control accuracy of 2% at flows to 2000 SCFH. Two models are available. One delivers 0 to 40 psi and the other 0 to 140 psi and both can handle inlet pressures up to 3000 psi. Use them on any gas compatible with 2024-T4 aluminum alloy, neoprene, polyurethane and Buna-N.

If what we've said sounds good so far, but still won't solve your problems, read on.

We've built a regulator specially for corrosive gases and atmospheres. Available in either all monel or all stainless steel construction, we call it the 640 Series. Spec sheets on this can be had by marking an "X" below.

If you "X" the next box, you'll get a package of useful information on a special regulator that will handle delivery pressures up to 4500 psi with very high control accuracy. This is a 2 stage spring and dome loaded regulator and we claim that a 50% change in inlet pressure will not change the delivery pressure more than 2%. Operation is simplicity itself. For no particular reason, we call this the 920 Series.

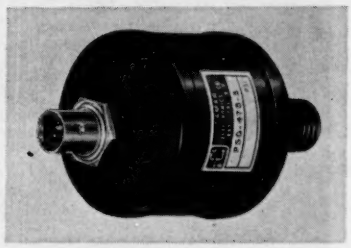
Skeptics should send for all of this information.

For reasons now hidden by the veil of tradition, no one has ever attempted to scrunch a pressure switch to its proper proportions—that is, until now. With sales getting bigger from making things smaller, we decided that this was the path to profit. Ergo; the new Hoke Pamar pressure switch.

This isn't just a case of arrested development, but something entirely new. The scrunching process necessitated less parts, so conventional connecting linkages were the first to go. The direct result: a switch with only one moving part—nothing to wear and upset the actuation setting.

The ordinary bellows was out of the question, so we used a Ni Span C capsular type sensing element. Out of this came such things as high repeatability, minimum hysteresis and drift, maximum temperature stability, and a dead-band of minor significance.

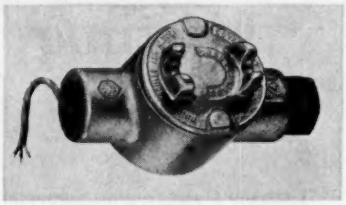
The whole assembly measures less than 2 inches from tip to terminals, and weighs short of one ounce. Despite these diminutive dimensions, it is capable of handling working pressures to 500 psi with a repeatable accuracy of ±0.5%. Electrically, it sports a snap-action switch that will conduct a current of up to 7 amps to a variety of connectors – AN, cabled leads, solder terminals, or whatever you want. Interested in pressure switches for explosive atmospheres? Specify the explosion-proof model.



A special low pressure switch (0 to 7 psi) defies competition with a dead band of 2" of water!

If what you're looking for in a pressure switch seems impossible to find (even with the wonders we've described here), we'd like to hear about it. We thrive on doing what others shrink from, and will build a switch to your specs. Write and tell us your problem.

We could go on, but that wouldn't leave us with the usual advertising "hooker". We want to hear from you. In return, we'll send you the rest of the story.



WHAT'S NEW FROM HOKE?

Lots of things have been happening at Hoke. To be sure you're up to date on these developments in fluid control see your nearest distributor. He'll have something new for you every other month this year.

Hoke's Performance Guarantee—*Every Valve Leak-Tested!*

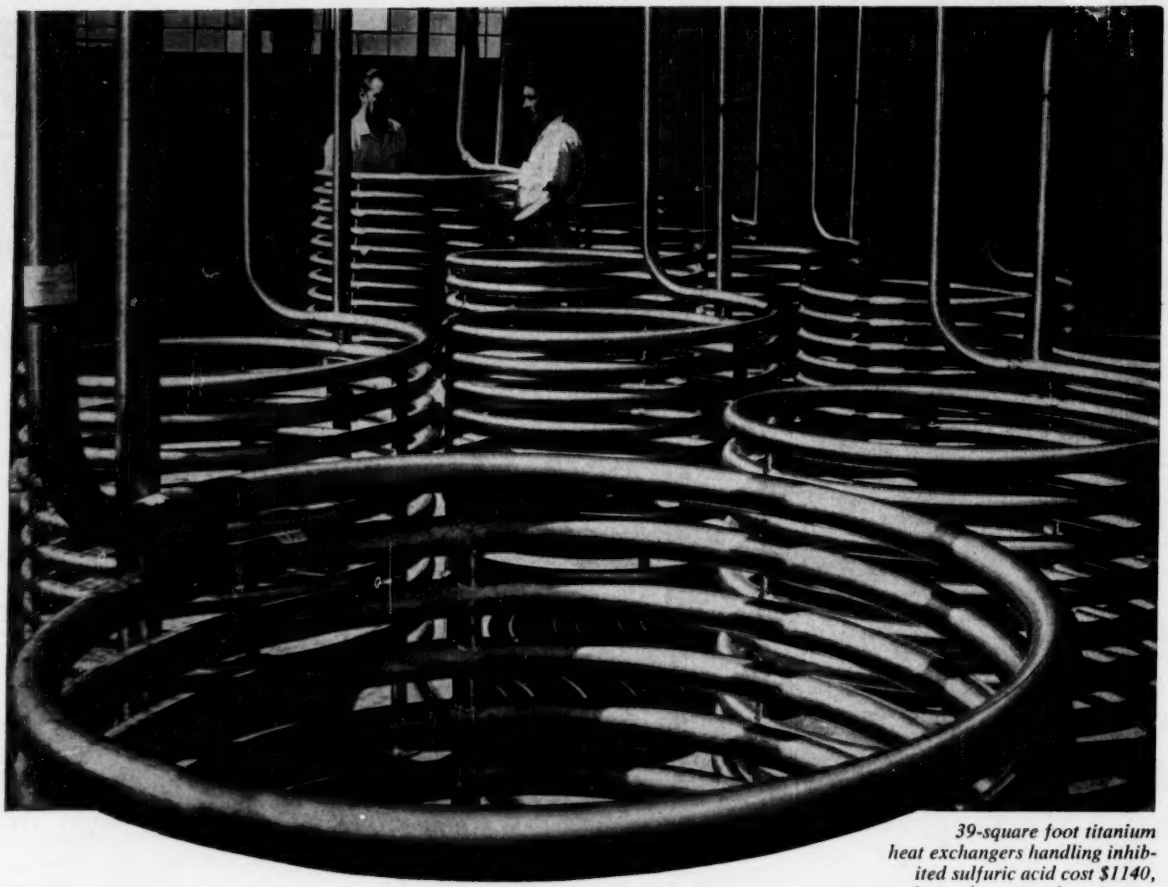
HOKE INCORPORATED
39 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

- ☐ Pamar Pressure Switches
- ☐ 680 Series Regulator
- ☐ 640 Series Regulator
- ☐ 920 Series Regulator
- ☐ "What's New"

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ STATE _____

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE



39-square foot titanium heat exchangers handling inhibited sulfuric acid cost $1140, replace conventional equipment priced at $1111. Result . . .

Lifetime Titanium heat exchangers pay for themselves in nine months!

Titanium's anti-fouling characteristics, its corrosion immunity in inhibited sulfuric acid, and its competitive prices have combined to solve a major production problem at two large pigment plants.

Forty-five titanium heat exchangers, manufactured in eight weeks, have been sped into service in a 30% sulfuric acid solution inhibited by metallic sulfates. They replace standard-metal equipment which has yielded a nine-month service life. Project engineers state: "Titanium will last a decade."

The self-cleaning titanium heat exchangers retain high heat transfer indefinitely . . . have permitted a steam cutback from 125 lbs to only 30 for an identical heating job. Yearly savings in steam and maintenance are valued at $50,000.

Progress in titanium raw material prices and fabrication costs makes the application possible:

Fabrication. Selection of the *right* fabricator is always important; with titanium, vital. Example: construction quotes from six bidders ranged from $363 to $2000 per heat exchanger. Either extreme could have prevented the application, but one source—recommended by TMCA—covered quality and price requirements like a blanket. . . . Saffran Engineering Company's $464 per unit. The picture then showed:

Price. Conventional heat exchangers at $1111; the titanium units at $1140! The titanium test model, installed in 1957 and still operating, cost $2290. Titanium prices have been cut in half in the last four years!

If you are faced with maintenance problems in equipment operating in inhibited sulfuric acid . . . or wet chlorine . . . or hypochlorites . . . or urea . . . titanium merits serious study. TMCA can help you locate the fabricator best qualified for your specific need . . . the economies can be yours for the asking.

Get the facts: The welding story . . . performance data . . . history of these titanium heat exchanger coils. Write today.

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from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

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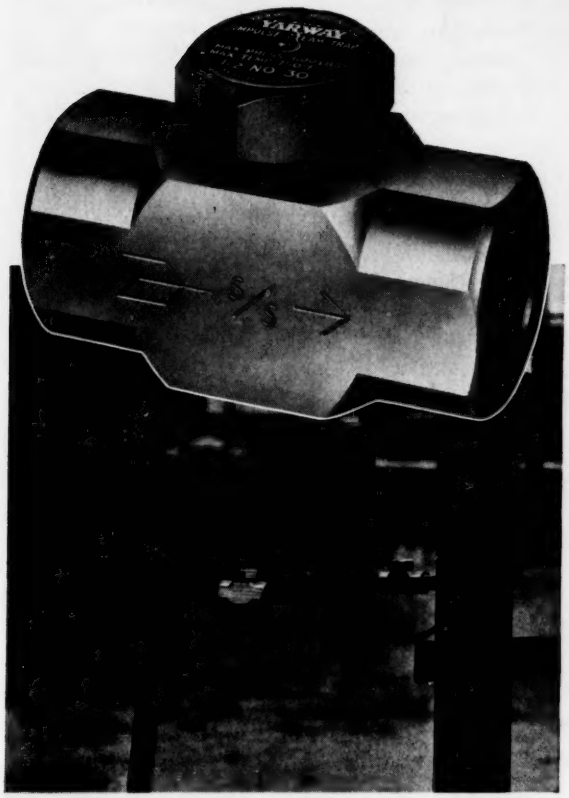
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

YARWAY SERIES 30 IS THE STEAM TRAP FOR PEAK EFFICIENCY



Two Yarway Series 30 traps on tracer lines from a loading station to polystyrene storage tank at the Midland Division of The Dow Chemical Co., Midland, Mich. Steam pressure is 150 pounds.

on tracer lines, main drips, meter boxes and other steam equipment

Yarway Series 30 Impulse Steam Trap has won enthusiastic acceptance and scored outstanding success on those hundreds of applications where condensate is handled in moderate amounts. Here's why:

- Economy of operation, with closer condensate control
- Longer service life, with lever action reducing impact on valve seat
- Lower maintenance, with easily and quickly replaceable seat and disc
- High quality, all stainless steel—combined with a new low cost

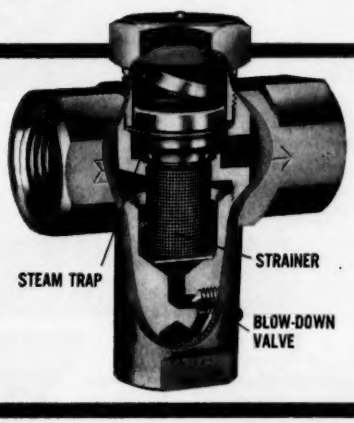
Here are a few typical user experiences:

TEXAS REFINERY—*Been using ½" No. 30's on drip legs to steam lines for 6 months. "No troubles whatsoever."*

PENNSYLVANIA TIRE MFR.—*Gradually replacing all traps on tire molds with Yarway No. 30's. "Amazed at their performance."*

MISSOURI STEEL PLANT—*Tested Yarway No. 30's against competitive traps, with result "Yarway No. 30 now standard on all main steam header drips."*

So it goes in plant after plant. Why don't *you* try Yarway Series 30 Traps? Available in ⅜" or ½" size; pressures 8 to 600 psi. Your nearby Industrial Distributor carries them. Write for his name.



NEW! COMPACT COMBINATION

NEW SERIES 130 steam trap combines a Series 30 trap, a strainer, and blow-down valve *all in one compact unit*—with these advantages:

- Saves space
- Saves installation costs
- Saves weight
- Saves on maintenance

Stainless steel construction, good for all pressures 8 to 600 psi.

Your Yarway distributor has SERIES 130 traps. Try one today—or write for new Bulletin T-1743-B.

handle sensitive materials safely

■ Creating new materials and using the latest methods to produce them profitably helps the plastics industry set the pace of our industrial growth. One of the most advanced techniques now in use is controlled atmosphere conveying, pioneered by Dracco to provide safe handling of sensitive dry bulk materials.

Controlled atmosphere conveying is a refinement of Dracco techniques for automatic bulk handling, already used by most polyolefin producers. Closed-circuit conveyors carry materials throughout production on a stream of gas whose properties are carefully controlled.

Inert gas or dry, filtered air may be used as the conveying medium where moisture, oxygen or airborne contamination must be eliminated. Temperature may be regulated during handling. Explosion or combustion hazards are prevented.

Systems are fully instrumented and equipped to record pressure and temperature, analyze oxygen content, actuate control devices which avert danger, generate gas, provide cooling, and prevent leakage.

Safe, high-purity bulk flow is just one of the benefits of these systems. They also provide the economies built into all Dracco Airstream Conveyor Systems — minimum labor and low maintenance, plus installation and operational versatility.

For details on how Dracco can insure the special care you need in handling sensitive materials, write Dracco Division of Fuller Co., Harvard Avenue and East 116th Street, Cleveland 5, Ohio.

. . . with Dracco ***controlled atmosphere*** *conveyors*

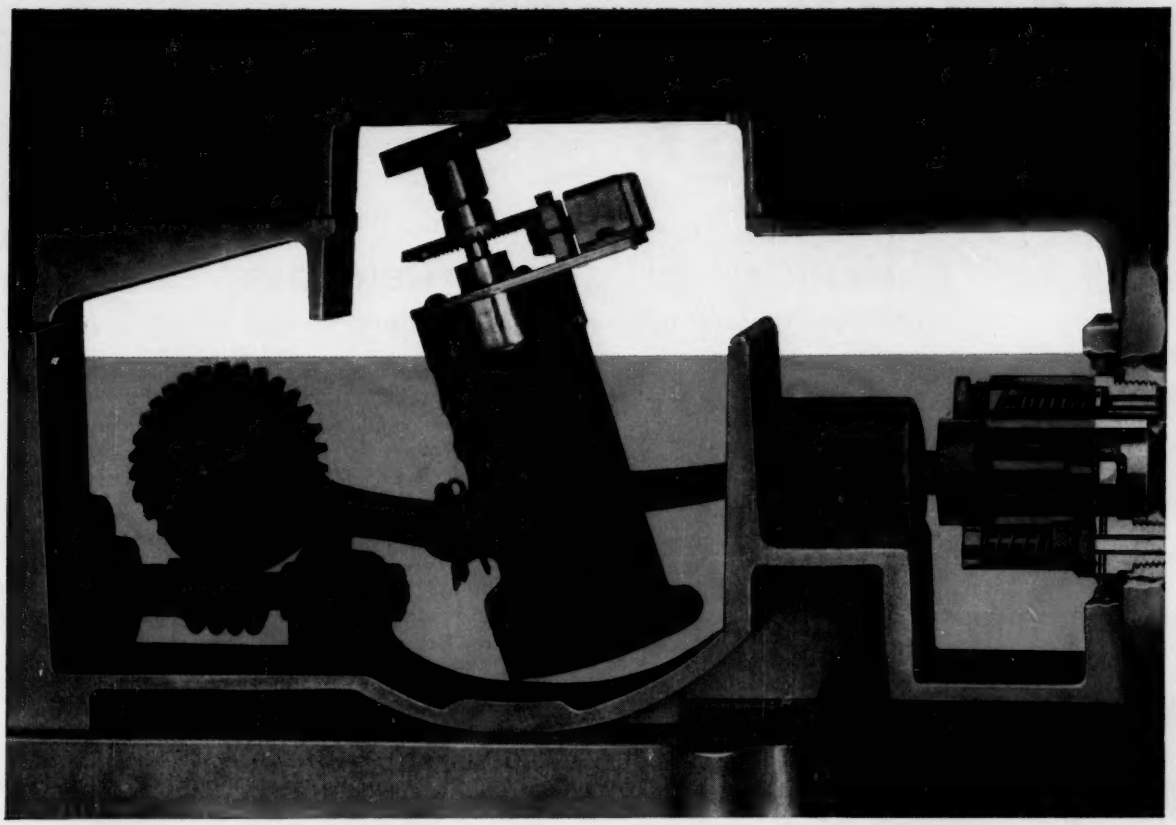
Consulting Engineers: Fluor Corp.

Polyethylene handling complex at W. R. Grace & Co.'s Baton Rouge plant includes six Dracco controlled atmosphere conveying systems which move materials from dryers through process to storage and bagging. Operation requires only part-time supervision of three men at control panels. Handling capacities range from 3½ tph to 22½ tph.

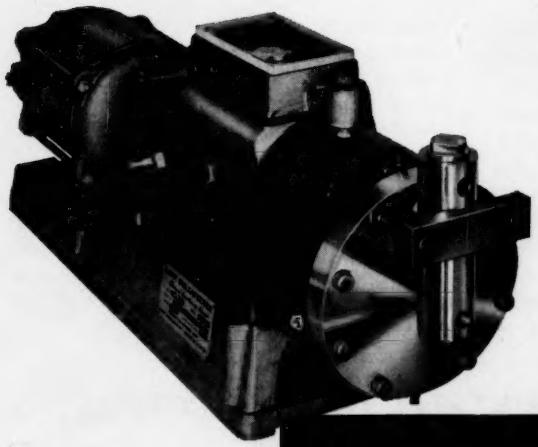
See Chemical Engineering Catalog for details . . . or write for 32-page Bul. 530, "Dracco Airstream Conveyors".

DRACCO *airstream* conveyors
dust control equipment

FULLER COMPANY



This is why you never heard of a PULSAFEEDER wearing out!



Every moving part of every Lapp Pulsafeeder Metering Pump is completely submerged in oil. This total lubrication reduces friction to practically the theoretical minimum. And there's no possibility of corrosion from exposure to atmosphere.

For year after year of *extra* service life, Lapp Pulsafeeders continue to give you the exclusive advantages for which you bought them. Advantages like complete freedom from leakage and contamination; precision metering, at flow rates from a few drops to 15.7 gallons per minute; pressures up to 7000 psig; choice of heads for safe handling of acids, abrasive slurries, radioactive fluids; manual or instrument controls. We've got a new catalog to help you fit the right model to your process.

Lapp

***WRITE** for Catalog 59. Lapp Insulator Co., Inc., Process Equipment Division, 1115 Poplar Street, LeRoy, N. Y.*

sharp

AMERICAN BI-METAL THERMOMETERS make accurate temperature readings sharp and sure at all check points

American Dial Thermometers are also available in mercury, vapor pressure, and gas actuation . . . on-the-spot and distant reading types . . . in sizes, ranges and stem lengths to meet your most exacting requirements.

sensitive

Any way you look at an American Bi-Metal Thermometer, you see exact working temperatures.

The two-level "Maxivision®" dial eliminates parallax effects. Numerals are on the lower level. Graduations are on the outer raised ring dial which presents a sheared edge to the tip of the pointer and in the same plane. To make readability even more accurate, the glass and graduated dial are closely spaced.

American Bi-Metal Thermometers are made of weather-proof stainless steel. All joints are welded to solid unity, then polished smooth so corrosion won't build up and destroy the thermometer's usefulness. And, you don't have to discard this thermometer even if the glass is ever broken. The bayonet lock bezel makes replacement easy.

Learn about the high sustained accuracy and long service life built into American Bi-Metal Thermometers. Phone your nearby industrial supply distributor for help in selecting the right type for each temperature check point in your plant. Or write for Catalog 155.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

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A product of

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ordinary?

Soda ash might be considered an ordinary chemical. But, add three score and more years of experience in producing it, transporting it, studying it in use. Combine with mature and alert technical service. Crystallize with an understanding of the growing needs of industry on the move, and you have the formula for an extra-ordinary chemical . . .

Wyandotte Soda Ash

MAIL THIS CARD FOR MORE DATA ON SODA ASH

ANOTHER WYANDOTTE KEY CHEMICAL

Yes

CUT OUT, FOLD, STAPLE, AND MAIL TODAY!

Send technical data on Wyandotte ☐ light soda ash ☐ dense soda ash grades. Include price sheets on ☐ carload quantities ☐ L.C.L. quantities. ☐ I'd also like information on slurry handling of soda ash.

I use soda ash for_____

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COMPANY_____

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Top news stories and what they mean to CPI technical decision-makers

Chementator

First shipment of petronaphthalene eases tight aromatics market

First shipment of naphthalene made from petroleum poured into the domestic market last month. Produced at Ashland Oil & Refining Co.'s new plant near Ashland, Ky., the 50,000-gal. delivery will help to alleviate the current napthalene shortage, prolonged because of lower coal tar naphthalene supplies resulting from depressed steel production.

Ashland thus won the race as the first company to get a Hydeal unit on stream to make commercial quantities of petronaphthalene. Licensed by Universal Oil Products, the Hydeal process is prominently featured in the current dizzying upswing in benzene and naphthalene capacity planned and under construction. At least 11 other Hydeal units have been licensed for making one or both of the products that once were obtained almost entirely from coal tar sources.

Ashland's new plant will produce 75-100 million lb./yr. of naphthalene and up to 6 million gal./yr. benzene at full capacity.

New twist around the old cocoon: spherical filament-wound vessels

Keep your eye on filament-wound vessels, say trade sources. The technique of filament winding, originally borrowed from rocket-case manufacture, yields lightweight, superstrong process and storage vessels in capacities up to 20,000 gal. Items:

• Justin Enterprises, Cincinnati, reveals that it has successfully fabricated a new filament-wound shape—the sphere. (Until now, vessels have been exclusively cylindrical.) JE's tanks are wound like cocoons with specialty bisphenol-A polyester resin, which is more resistant than general-purpose polyesters to acids, alkalis and bleaches at elevated temperatures. Furthermore, the spheres can be inner-lined with a variety of plastics to withstand exceptionally corrosive effects caused by unusual conditions.

JE will start production with 6- and 8-ft.-dia. (1,000 and 2,000 gal. capacities) vessels, then move to larger spheres.

• Almost simultaneously, *CE* learns that Black, Sivalls & Bryson (Kansas City, Mo.) has begun operations at its "full scale" production unit in Ardmore, Okla. Highly automated, the facility turns out BS&B's line of 10- and 12-ft.-dia. cylinders from punched-tape specifications. Until the plant came on stream about a month ago, BS&B was fabricating its epoxy-bonded glass-fiber tanks in research and development labs.

Production of acetic and formic acids from NSSC liquor revealed

After two years of shakedown operations, Sonoco Products has furnished the first details of its acetic-formic acid plant at Hartsville, S. C. During the recent TAPPI meeting in New York, Sonoco disclosed that the plant—which wrings the two acids from neutral sulfite semichemical (NSSC) black liquor—has had most of the technical bugs removed.

But one big problem remains: the plant isn't self-sustaining economically. Sonoco says, however, that it hopes to be able to turn the operation into a money-maker in the near future.

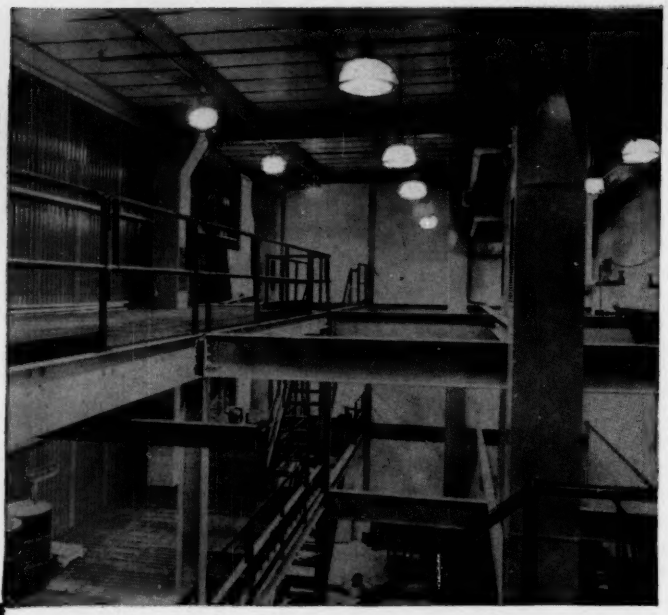
Here is a brief description of the Sonoco process: NSSC liquor from the 350-ton/day pulp mill is evaporated to 40-45% solids, then is acidified with sulfuric acid in an inline blender. Acidification frees acetic and formic acids from their corresponding sodium salts.

The two acids are then extracted from the liquor with MEK. After stripping the acids from the solvent, they are separated by azeotropic distillation with ethylene dichloride. Further distillation produces glacial acetic acid (99.5%) and formic acid that is about 90% pure.

On stream since June 1958, the plant has experienced plenty of technical problems. Mixed acetic-formic acids are extremely corrosive and

LIGHT

exactly where you need it...



Crouse-Hinds Explosion-Proof Lighting Fixtures in Class I, Group D location

Crouse-Hinds Vaportight Lighting Fixtures in a corrosive outdoor location

regardless of surrounding atmosphere!

When there's something in the air — explosive gases, ignitible dusts, corrosive fumes — Crouse-Hinds has exactly the light to give you lighting exactly where you need it — with complete safety!

Lighting that's safe to operate in explosive concentrations of acetylene . . . hydrogen . . . gasoline vapors . . . organic, inorganic or metallic dusts. Lighting that stands up under the corrosive attack of acids, salts, alkalis.

What *kind* of lighting do you need: Bench . . . area . . . flood? Incandescent . . . fluorescent . . . mercury vapor? Permanent . . . portable?

You'll find them all in the Crouse-Hinds catalog. It's the *only* place you'll find lighting for every Class and Group under the National Electrical Code.

Ask your Crouse-Hinds Distributor.

Crouse-Hinds Dust-Ignition-Proof Lighting Fixtures in grain elevator — a Class II, Group G location

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OFFICES: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington

RESIDENT REPRESENTATIVES: Albany Baltimore Reading, Pa. Richmond, Va.

Crouse-Hinds of Canada, Ltd., Toronto, Ont. Domex, Mexico City, D.F. Peterco, Sao Paulo, Brazil

although the plant is constructed of stainless steel, major corrosion problems were encountered in the refining section. Product color has also caused headaches; although commercial shipments of glacial acetic are now being made, formic sales have been prevented because of the firm's inability to produce a sufficiently colorless acid.

Decision should be coming soon from the General Services Administration on the bid of Deuterium Corp. to purchase the Morgantown, W. Va., Ordnance Works for $1.5 million. The heavy - water - oriented company (Chem. Eng., Oct. 17, 1960, p. 94) plans initially to start up the ammonia, methanol and formaldehyde units.

Chalk up another process for producing petrochemical benzene

With the ink barely dry on the announcement by Houdry Process Corp. of its Detol route for making benzene from petroleum (*Chementator*, Feb. 20, p. 73), another process has been entered in the wide open race to expand benzene capacity.

Developed by Atlantic Refining Co. and Hydrocarbon Research, Inc., the scheme shuns catalytic hydrodealkylation used by Houdry (and Universal Oil Products in its Hydeal process). Instead, it obtains dealkylation by thermal treatment of the feed stream in the presence of hydrogen.

Atlantic-HRI flowsheet is called "The HDA Process" (short for The Hydrodealkylation Process). It will convert toluene, xylenes, ethyl benzene, pyrolysis gasoline and coke-oven light oil to benzene; starting with heavy reformate, catalytic-cracker cycle stocks, pyrolysis polymers and coal tar alkyl naphthalenes, it yields naphthalene.

In operation, incoming feed and hydrogen are preheated and passed to the reactor where hydrodealkylation takes place at 1,200-1,400 F. and what is described as "moderate" pressure. Products then go through a steam generator and a knockout drum, which separates unreacted hydrogen. A stabilizing tower removes paraffin hydrocarbons from the benzene or naphthalene, which is fractionated to obtain final product.

What must be accomplished in the thermal process is to exactly control the temperature in the reactor. Low temperature reduces yield, while high temperature leads to condensation, cracking and coke.

Prospective licensees have not been revealed by Atlantic or HRI.

For polyester fibers and films: new patent picture and producers

Patents have just issued to Goodyear on polyester resins from which Vycron fiber and Videne film are made. In turn, this is the year in which Du Pont's basic patents expire on Mylar polyester film and on Dacron polyester fiber.

According to the new patent, No. 2,965,613, Goodyear's resin is in the copolymer category. Raw material includes isophthalic acid, along with the terephthalic acid and ethylene glycol identified with Du Pont's resin.

These shifts in the patent situation coincide with considerable new capacity for both polyester fibers and films either at or near completion.

- Fiber Industries, jointly owned by Celanese and Imperial Chemical Industries, started up a 40-million-lb./yr. Fortrel polyester fiber plant in Shelby, N. C., late last year. This fiber is like Dacron since ICI and Du Pont both entered into licensing agreements in 1947 with the inventor, Calico Printers.
- Tennessee Eastman put the first units of its 20-million-lb./yr. Kodel fiber plant on stream last year; completion is due late this year. Kodel, like Vycron, differs from the Du Pont-ICI polyesters but Tennessee Eastman has not disclosed details.
- Vycron fiber, produced by Beaunit Mills, started coming out of a 12-million-lb./yr. plant about a year ago.
- Within the past two years, Du Pont more than doubled its Dacron capacity, bringing it to something over 75 million lb., with a new plant at Old Hickory, Tenn.

As for polyester film:

- Goodyear started up its 9-million-lb./yr. Videne plant last year at Point Pleasant, W. Va.
- Du Pont is almost ready to open a new Mylar plant at Florence, S. C., which will almost double present capacity. Centered at Circleville, Ohio, existing capacity has recently been boosted

(Continued on page 78)

Fast, easy cleaning of liquid dispersion bar and "Twin-Shell" interior speeds-up formulation changeover at Ortho.

P-K LIQUID-SOLIDS BLENDER GRANULATES TABLET FORMULATIONS IN A SINGLE STEP

PRE-BLENDS, DISPERSES, GRANULATES

A 10-cubic foot Liquid Solids "Twin-Shell"* Blender pre-blends dry tablet powders, disperses liquids into solids, and granulates tablet formulations in a single production step for Ortho Pharmaceutical Corporation, Raritan, N. J. It replaces equipment requiring multiple step processing.

The P-K Liquid-Solids Blender was purchased, according to John Colligas, Director of Pharmaceutical Manufacturing, "as a result of pre-testing, which demonstrated the unit's ability to precisely blend and granulate our material as well as provide versatility and close quality control. We need these features because of the varied formulations in our new line of tableted products."

P-K PRE-TEST RESULTS CONFIRMED

Before installation, specially selected formulations prepared by Ortho were tested in the Liquid-Solids Blender at the P-K Pre-Test Laboratory in East Stroudsburg, Pa. These results then formed the basis for more extensive testing of the blender at the Ortho Plant. Here, tests centered mainly around the precision blending of dry materials and uniform dispersion of liquids and solids.

In a dry blending test, research engineers put 0.5 gms. of activated charcoal powder into 29 lbs. of Ferrous Calcium Citrate-with-lubricant mixture, through the charge openings of the P-K Blender. Following ten (10) minutes of operation, one-pound samples were taken from each of the three openings and subjected to microscopic examination. *Counts showed total dispersion had been achieved.*

In a similar liquid-solids test, 50 pounds of powdered lactose were pre-blended. Then, a dilute solution of methyl violet (0.1 gm./1,000 gm.), in 300 gm. increments, were poured in. After blender operated for ten (10) minutes, the powder was removed. *Inspection showed a more homogeneous wetting than that achieved in tests of other equipment.*

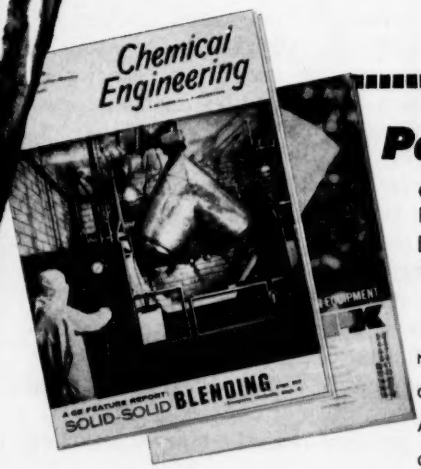
PRE-TEST BEFORE YOU BUY

Considering new solids processing equipment? You can justify investment—dispel or confirm doubts about purchase—at the P-K Pre-Test Laboratory.

Here, an unmatched range of solids processing equipment is available for testing: standard, intensifier, and liquid-solids "Twin-Shell" blenders, packaged tumble dryers; ribbon and doublecone blenders; and the new Solids-Processor* which telescopes up to ten operations in one unit. This equipment, plus the experience of engineers who have run thousands of resultful pre-tests can point the way to product improvement and process modernization.

Why not investigate? There's no cost or obligation. Write or dial George Sweitzer in Stroudsburg at HAmilton 1-7500 to discuss a pre-test date.

*patented



Patterson Kelley Chemical and Process Equipment Division
123 Burson Street, East Stroudsburg, Pa.

Gentlemen:
Please send me your (check one or both)—

☐ NEW REPORT ON SOLID-SOLID BLENDING. A 23-page cover article from *Chemical Engineering*, Aug. 8, 1960. Discusses blending theory, practice, equipment and economics.

☐ NEW P-K PROCESS EQUIPMENT CATALOG NO. 16-P. A 20-page bulletin, covers P-K pre-test services, lab and production blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, heat exchangers.

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30% to an estimated 20 million lb./yr. potential.

• Cronar, a film base for photo films that is another derivative of Du Pont's dimethylterephthalate resins, is made by the company at Parlin, N. J. Now Eastman Kodak has obtained a license from Du Pont and since mid-1960 has been making this same film base, under the designation Estar, at a new plant in Rochester, N. Y.

• Terrafilm Corp. has started construction on a 1 to 3-million-lb./yr. plant in Rockland County, N. Y., to make film—competitive with Mylar—from the same kind of resin used for Kodel fiber.

• Minnesota Mining also has polyester films based on a resin that is reported to contain, like Videne's resin, some isophthalic acid.

Scientific Design Co. is now offering an isoprene process for licensing outside the U. S. Route starts with propylene, forms propylene dimer, then demethanates. Process is jointly owned by Goodyear, is being used by that firm's 20,000-ton/yr. polyisoprene plant under construction at Beaumont, Tex.

Du Pont's first acetylene plant will use electric arc process

Moving into the acetylene field for the first time, Du Pont will build a huge plant at Montague, Mich., that will have a capacity in excess of 50 million lb./yr. Product will be used by the firm in a 60-million-lb./yr. neoprene plant already in operation on an adjoining site.

Based on a "modified electric arc" process that Du Pont says has been under development for 25 years, the plant can use either liquid or gaseous hydrocarbons as feedstock; cost will determine which. Natural gas is available by pipeline; other petroleum products would come from refineries in nearby Muskegon.

Consumers Power Co. says it will furnish the enormous amount of electricity needed at the "standard industrial high-load-factor rate," which is normally about 9 mils. But informed sources say that Du Pont may be able to obtain a lower rate because of the plant's large requirements.

Du Pont's move may be a serious blow to Union Carbide Olefins' Montague plant, which now supplies acetylene to the neoprene plant. Du Pont presently buys about 80% of UCO's acetylene output (estimated at 50-55 million lb./yr.). A Union Carbide spokesman tells *CE* that since the new plant will not be in full operation until 1963, it's too early to say what effect it will have on UCO's operations.

Curtailment of production at Montague would also affect Carbide's Sault Ste. Marie plant, which turns out 80,000 tons/yr. of calcium carbide, most of which is converted to acetylene at Montague.

Others to make polyacetal resins; lower prices may be in the offing

Last month, Celanese, Heyden Newport, and (in Japan) Catalytic Chemical Industry Co. announced their entry into the polyacetal resin field. Du Pont, now the only commercial producer of the resins, announced plans to cut the price of its product from 80 to 65¢/lb.

Celanese has begun pilot-plant production of Celcon, which it describes as an acetal copolymer based on trioxane, a formaldehyde derivative. Construction of a full-scale plant is under way at Bishop, Tex., scheduled to be completed early in 1962.

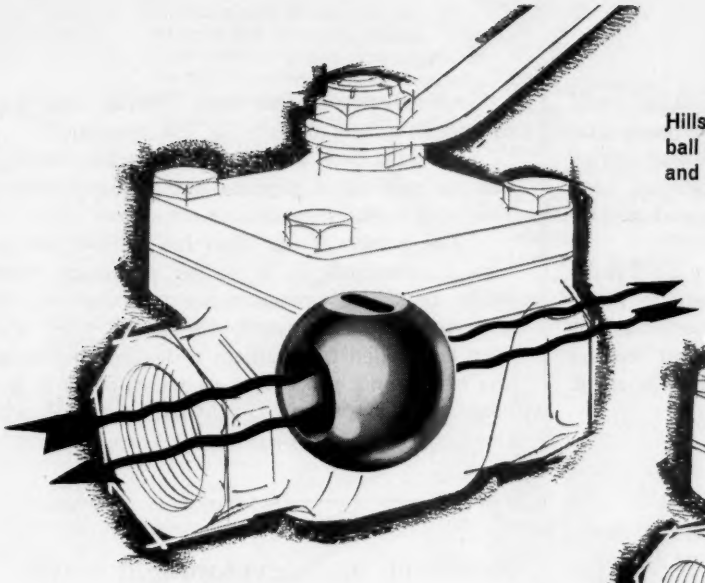
Heyden Newport hopes to have its polyformaldehyde project in semiworks stage by early 1962. The plant will be near the company's formaldehyde unit at Fords, N. J.

Catalytic Chemical Industry Co. will start soon on a pilot-plant level of 24,000 lb./yr. at Osaka, Japan.

Du Pont makes its polyacetal, Delrin, at Parkersburg, W. Va. Operating for about a year, the plant has an announced capacity of about 12 million lb./yr., but estimates of current sales volume would indicate a higher capacity.

The new entries believe they can stay clear of Du Pont's Delrin patents. Company's basic U.S. patent, No. 2,768,994, covers composition of matter (crystalline polyformaldehyde) and processes for making the material. Process described in this patent starts with pure formaldehyde. A Celanese patent, U.S. No. 2,951,059, describes manufacture of polyformaldehyde from trioxane, the cyclic trimer of formaldehyde.

Celanese predicts that the market for such

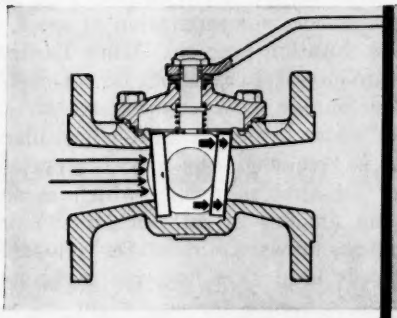


Hills-McCanna McCannaseal top-entry ball valves meet applicable API and ASA standards.

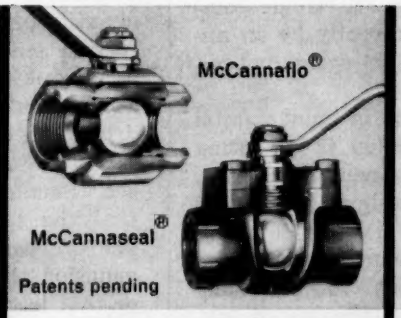
Ultra-simple design. The big orifice in the ball means minimum pressure drop. Double seats with floating ball provide two-way flow. Quick quarter-turn operation closes the valve.

Hills-McCanna Ball Valves

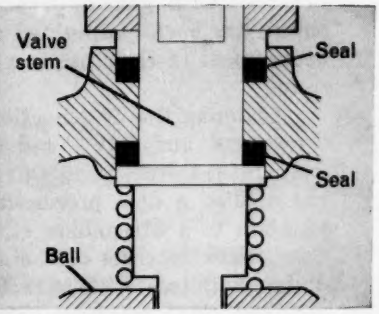
. . . the leaktight valves that end maintenance problems



Self-adjusting seats with leaktight pressure seal. McCannaseal seats move down into a wedge as wear occurs, maintaining tight contact with ball and body. Line pressure tightens the seal.



McCannaseal top-entry for in-line maintenance and McCannaflo for high-pressure lines. ¼" through 8" sizes, manual or motor-operated, screwed, flanged, or socket weld connections.



The stem is leaktight, too! Double seals are under compression by stem nut. Line pressure acts to further tighten and lower back-seated seal—the higher the pressure, the tighter the fit.

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BV61-1R

"high-performance engineering plastics" will triple during the next three years, reach 200 million lb./yr. by 1970. Among polyacetal's chief competitors are other engineering plastics such as polycarbonate and nylon resins, and metals such as die-cast zinc and aluminum.

Though most market observers expect polyacetal resins to remain specialty products, some note that price of formaldehyde monomer is not much above olefin monomers. At around 10¢/lb., formaldehyde is below the marketing price of styrene and vinyl chloride.

Two workers were killed and 32 injured in an explosion and fire at Ethyl Corp.'s Baton Rouge, La., tetraethyl lead plant on Mar. 2. Blast occurred in the wash house of Unit A where the distilled TEL is washed with water and aerated to remove impurities.

This digital computer finds "best" plant of thousands

Computation of engineering problems is beginning to shrug off its desk-calculator complex. Progress with general-purpose electronic computers has been highlighted recently by an announcement of their use in plant-design optimization.

Claiming 5-6% reduction in total capital investment and 5-10% reduction in operating costs, Shell Development Co., Emeryville, Calif., has applied a final process-design optimization program to a $10-million ethylene oxide plant. Comparison of costs of the computer-optimized design with costs of an actual conventionally designed plant produced the estimates of savings. Shell similarly tried the program on polyisoprene and cat-cracking processes.

Called CHEOPS (Chemical Engineering Optimization System) by the firm, the IBM 7090 program automatically and systematically examines a preliminary engineering design, changes process variables to determine effect on over-all plant economics. Three program decks of punched cards furnish data for this procedure:

- A logic deck provides instructions on how variables should be changed, based on an evolutionary-operation technique.
- A process-design deck details the engineered flowsheet design for the computer.
- A data deck contains information on labor and material costs, physical and chemical properties, and various constraints.

The program can examine 2,000-3,000 design alternatives in a matter of hours. And, aside from its optimum-design function, the program can also direct pilot-plant work that may be needed to complete a design. Although the firm won't say where or what, Shell is now constructing a plant that was optimized with the CHEOPS program.

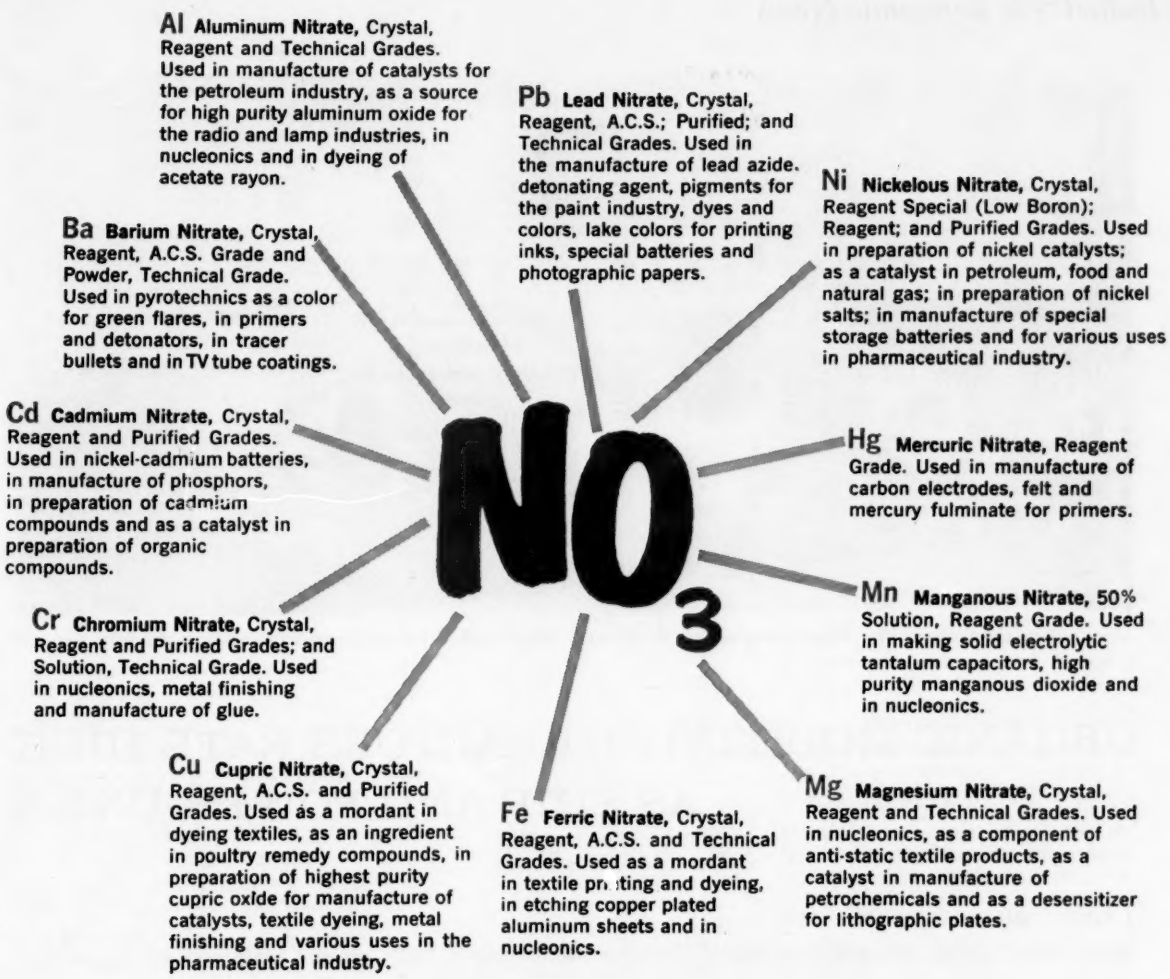
Research and development briefs

Carbon dioxide and water vapor are knocked out of air, prior to its liquefaction by a gauze wall cooled to —160 C., in a process developed by the Dutch firm, Philips. Bypassing the usual absorption systems that require air compression, Philips uses the method in conjunction with liquid air or liquid nitrogen machines, obtaining cooling for the gauze through copper rods connected to the machines' cold condenser heads. Layers of snow up to 4 in. thick form during normal operation.

Ultrasonic vibrations cut down markedly on the quantity of oil needed for separation of ore and rock in a new flotation process. Henry Zaruba, a Yugoslavian engineer working for Quebec's department of mines, uses compressed air to drive a jet of water against a knife-edged blade that vibrates at frequencies up to 45,000 cycles/sec. Smaller oil bubbles result, which means that the same amount of oil can carry more fine ore particles upward out of the oil-water emulsion that is used as a flotation medium—or that less oil is needed for equivalent ore recovery.

Increased rate of heat transfer is reported by Robert Lemlich of University of Cincinnati. An inexpensive solenoid valve installed upstream from a heat exchanger is arranged to open and close at about 1.5 cycles/sec. via an adjustable pressure switch. Resulting pulsed flow increases over-all heat transfer coefficient 80% at a Reynolds number of 2,000, 20% at 11,000. Pulsations also help loosen and clear out some exchanger fouling.

For More Industry & Economic News . . . p. 82


Al Aluminum Nitrate, Crystal, Reagent and Technical Grades. Used in manufacture of catalysts for the petroleum industry, as a source for high purity aluminum oxide for the radio and lamp industries, in nucleonics and in dyeing of acetate rayon.
Pb Lead Nitrate, Crystal, Reagent, A.C.S.; Purified; and Technical Grades. Used in the manufacture of lead azide, detonating agent, pigments for the paint industry, dyes and colors, lake colors for printing inks, special batteries and photographic papers.
Ni Nickelous Nitrate, Crystal, Reagent Special (Low Boron); Reagent; and Purified Grades. Used in preparation of nickel catalysts; as a catalyst in petroleum, food and natural gas; in preparation of nickel salts; in manufacture of special storage batteries and for various uses in pharmaceutical industry.
Ba Barium Nitrate, Crystal, Reagent, A.C.S. Grade and Powder, Technical Grade. Used in pyrotechnics as a color for green flares, in primers and detonators, in tracer bullets and in TV tube coatings.
Cd Cadmium Nitrate, Crystal, Reagent and Purified Grades. Used in nickel-cadmium batteries, in manufacture of phosphors, in preparation of cadmium compounds and as a catalyst in preparation of organic compounds.
NO3
Hg Mercuric Nitrate, Reagent Grade. Used in manufacture of carbon electrodes, felt and mercury fulminate for primers.
Mn Manganous Nitrate, 50% Solution, Reagent Grade. Used in making solid electrolytic tantalum capacitors, high purity manganous dioxide and in nucleonics.
Cr Chromium Nitrate, Crystal, Reagent and Purified Grades; and Solution, Technical Grade. Used in nucleonics, metal finishing and manufacture of glue.
Cu Cupric Nitrate, Crystal, Reagent, A.C.S. and Purified Grades. Used as a mordant in dyeing textiles, as an ingredient in poultry remedy compounds, in preparation of highest purity cupric oxide for manufacture of catalysts, textile dyeing, metal finishing and various uses in the pharmaceutical industry.
Fe Ferric Nitrate, Crystal, Reagent, A.C.S. and Technical Grades. Used as a mordant in textile printing and dyeing, in etching copper plated aluminum sheets and in nucleonics.
Mg Magnesium Nitrate, Crystal, Reagent and Technical Grades. Used in nucleonics, as a component of anti-static textile products, as a catalyst in manufacture of petrochemicals and as a desensitizer for lithographic plates.

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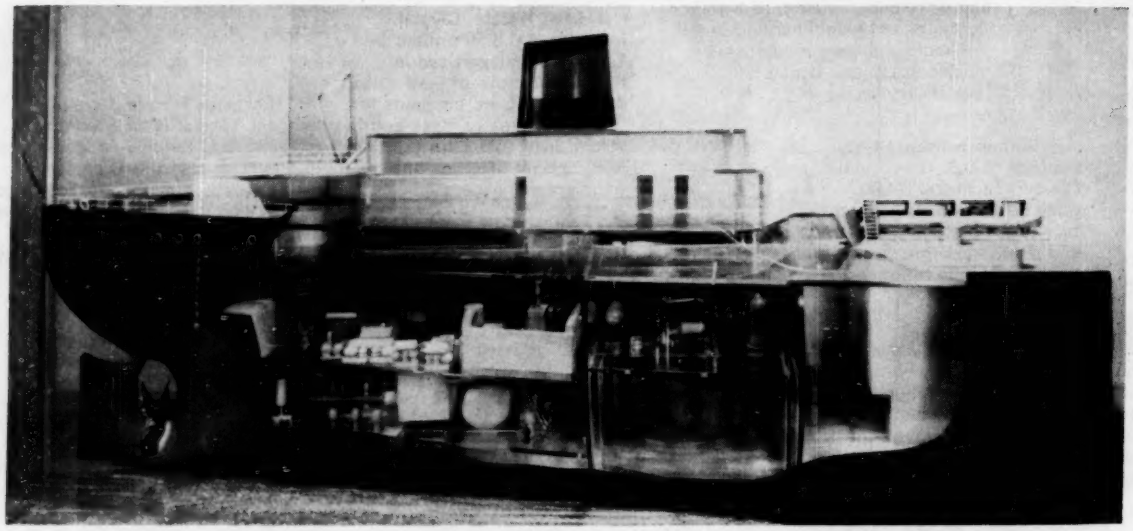


Nuclear tanker. The organic reactor can fit in space usually allocated to steam-generating equipment.

ORGANIC-MODERATED REACTORS RATE HIGH AS SHIP AND POWER UNITS

Their attractiveness for merchant ship propulsion is internationally acknowledged. A recent study finds them competitive as a power source.

Organic-moderated reactors have been given a big boost. At the recent symposium on Nuclear Ship Propulsion in Taormina, Italy, where 37 papers were presented by delegates from 19 countries, the consensus was that in the next few years OMR's will make nuclear-propelled ships competitive.

Talks at Taormina highlighted commercial developments already under way all over the world. Here is a sample of what is going on:

• Germany has already entered the hardware stage for an organic-reactor-propelled ship, and has been getting bids from various shipyards.

• Interatom, German affiliate of Atomics International, Canoga Park, Calif., is developing a test reactor for 10,000 shp., capable of propelling tankers of up to 40,000 deadweight tons.

• In Italy, Fiat and Ansaldo are planning a 50,000-ton tanker.

• In Japan, 25 nuclear-propelled ships have been designed, and Kawasaki and Mitsubishi have built full-scale models to determine dynamic characteristics and to test thermal and residual stresses after pressure and temperature cycling.

• Britain is asking for bids on its first nuclear merchant ship, and should reach a decision this month. The British have in mind a 20,000-shp. unit for a 65,000-ton tanker, have narrowed the choice to either an organic or boiling water reactor.

▶Why the Bustle? — Present attention to organic reactors stems from the realization that nuclear-propelled ships can travel on long voyages, at high speeds, with minimum fuel requirements and constant capacity of cargo. For the first designs, therefore, large oil, ore and grain carriers are the logical types of ships.

But the reactors' great potential in ship propulsion and power generation comes from these appealing features:

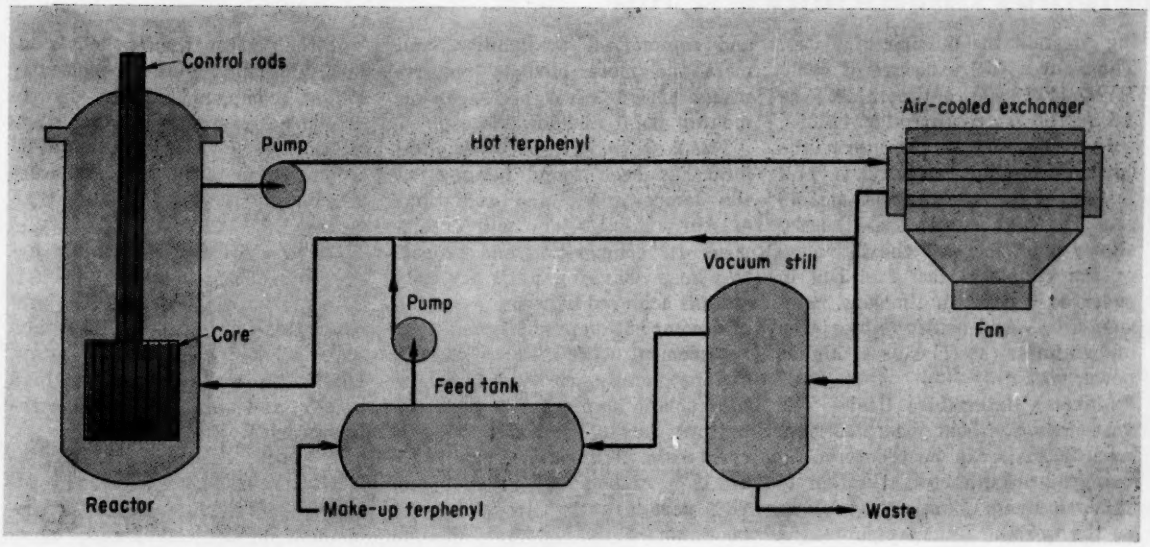
• The high-boiling organic coolant (also acting as the moderator) operates at low pressures, allows use of simple mechanical components and lightweight reactor vessels, piping and associated equipment.

• Coolant is noncorrosive, therefore permits low-cost materials of construction.

• Neutron moderation provided by the hydrogen content of the organic coolant eliminates bulky structures and shielding weights.

• Exposure to neutrons in the reactor core has a mild effect on the organic coolant, hence most of the equipment in the nuclear system can be accessible for inspection and maintenance.

▶What About Cost? — Lending further substance to the optimism



Experimental reactor features low induced radioactivity in the coolant plus ease of operation and maintenance.

expressed at Taormina are the results of a study on power costs for a 300-Mw(e) OMR, recently declassified by the Atomic Energy Commission. Most surprising discovery in the study (conducted by Atomics International) is that power cost doesn't depend on moderator-to-fuel ratio, which in many other types of reactors greatly affects power density. And high power density often means lower capital cost.

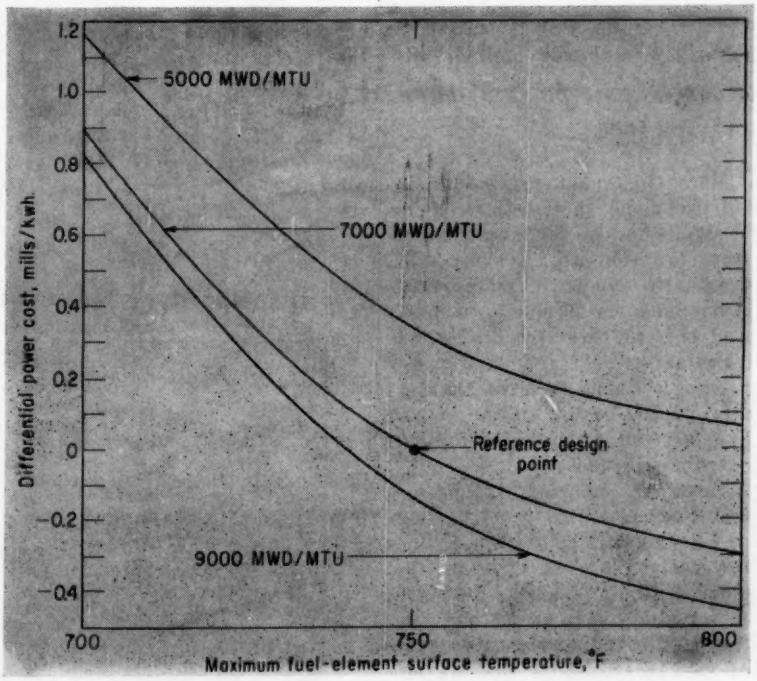
Presumably, this insensitivity comes from the low pressure of the coolant and from the lack of stored mechanical energy in the coolant system. Thus, the effects of large size in increasing the cost of the reactor vessel and related equipment are considerably tempered.

▶**Basis of Study**—First step in the study was to define a reference design for the reactor. Variations of the parameters—such as perturbations in fuel, organic makeup and primary heat transfer, which comprise about 65% of the cost of nuclear power—were then investigated and evaluated in terms of the change that they might produce in total power-generation cost.

Important cost-determining parameters are fuel cladding, surface temperature and hot channel factors. Considerable savings can be realized by flattening the radial and fuel-element neutron-flux distributions, with additional savings accruing when fuel exposures* increase from 5,000-9,000 MWD/MTU (see accompanying graph).

An optimum M/F (moderator-to-fuel ratio), dependent on fuel exposure, can be found by varying the fuel-plate thickness while keep-

* Fuel exposure = heat released in megawatts per day (MWD)/unit weight of fuel fed, metric ton of uranium (MTU).



When fuel exposures are increased, decided savings in power costs are realized.

ing constant the number of plates. Thus, for a fuel exposure of 5,000 MWD/MTU, the optimum M/F is 4.5, increasing to around 5 at 7,000.

In a reactor of this type, the optimum coolant velocity is 11.2 ft./sec., a purposely low value because at higher velocities the designer must increase the thickness of the stainless steel fuel box in order to cope with the flow pressure drop. And neutron absorption on stainless steel causes higher power costs.

► **Makeup Determines Cost** — The vast amount of heat generated from nuclear fuels can be recovered by using an organic coolant, either to produce steam (indirect cycle) or as the working fluid for running a turbomotor (direct cycle).

Such a coolant should be exceptionally stable, have low unit cost and commerical availability, and meet the more obvious requirements of low vapor pressure, low melting point and low viscosity.

Needless to say, no such ideal fluid has been found because, at the temperatures and radiations existing, any coolant will decompose. Its composition and properties keep changing until a steady state is achieved between formation of decomposition products and their replacement with makeup coolant.

Consequently, cost of replacing the coolant becomes the most important factor, exclusive of fuel cycle costs. For instance, a mixture of 12% ortho-, 60% meta-, and 28% para-terphenyl, in spite of its poor thermal conductivity and high melting point, is now used in the experimental OMR because it costs only 17¢/lb.

In the reactor, the terphenyls decompose into higher molecular weight compounds, light hydrocarbon gases, traces of compounds in the same volatility range as diphenyl and terphenyls, and compounds slightly more volatile than diphenyl.

Decomposition gases contain hydrogen (63%), methane (11%), ethane and ethylene (19%), propane and propylene (5%) and other light hydrocarbon gases. Distillation units recover the high boilers, and degasifiers remove the hydrocarbon gases.

It is possible, therefore, that the OMR may become a chemical processing reactor, and partial reconstitution of the coolant from waste materials through hydrogenation or catalytic cracking is being seriously considered.—EG

COLOR RIDES SYNTHETIC FIBERS' RISE

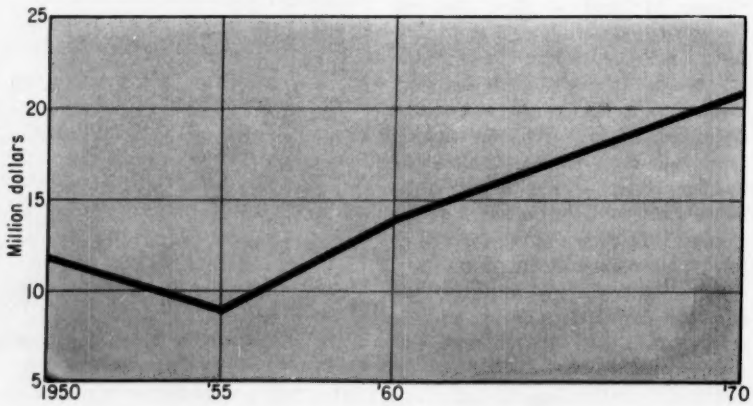
As synthetic fibers grow in maturity, manufacturers are turning to color as an increasingly important competitive tool.

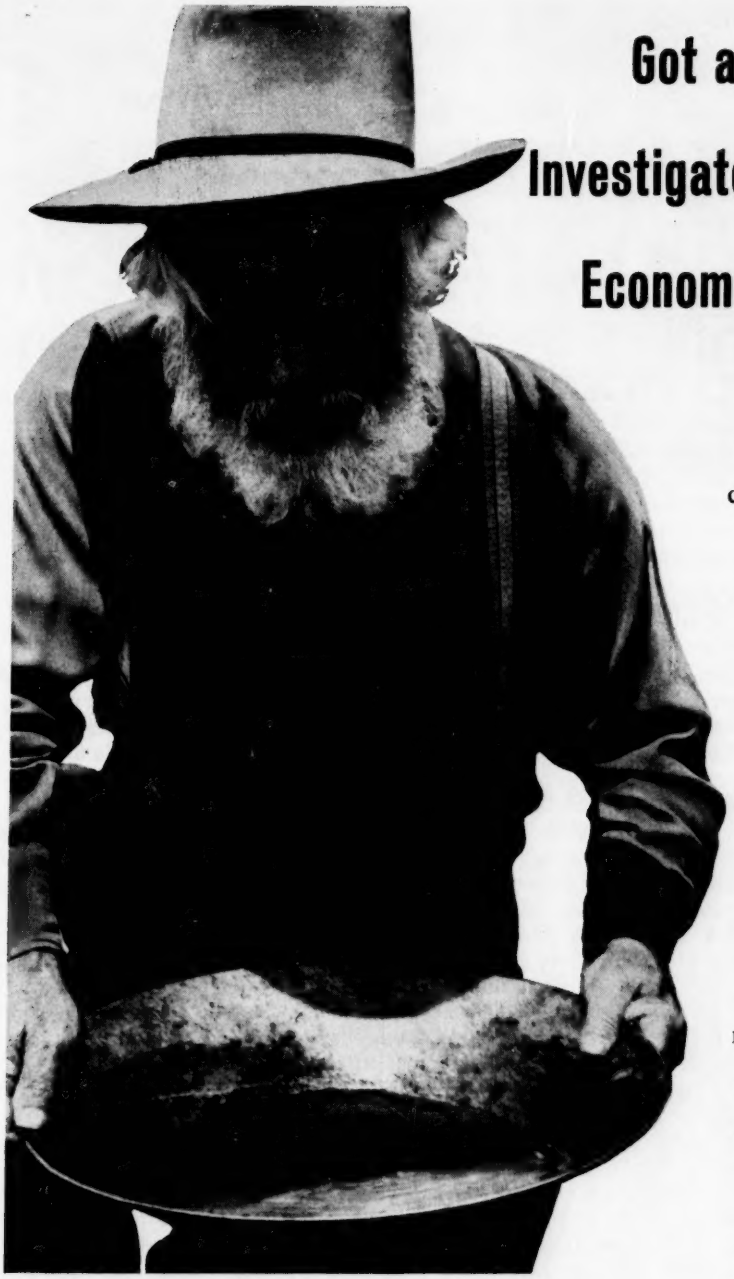
Many informed specialists in polypropylene now believe it to be such a natural for textile manufacturing that this market will eventually consume more than either plastics products or film. And current fever pitch of resin manufacturing plans and prospects is pressing for creation of a total market of 500 million lb./yr. by 1965—up from 35-40 million consumed in 1960.

However, coloring polypropylene fiber is still a problem, just as coloring was a problem during the early years of each of the older synthetic fabrics. So big a factor did this turn out to be in the textile industry's acceptance of earlier synthetics that an enlightened chemical industry is now resisting premature introduction of polypropylene fibers, even in the face of the pressing need for big markets.

Synthetic fibers, in turn, have become a big factor for colorants, now represent nearly 15% of a total $200-million/yr. dye market, plus a few million dollars additional for pigments. Use of noncellulosic synthetics in textiles grew 428% between 1950 and 1959, from 140.5 million lb. to 743 million, is due for another 10.7% jump by 1965.

Disperse dyes—color's big winner on synthetics





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Write indicating the nature of the material to be extracted. For physical data, write for Bulletin 203-A.

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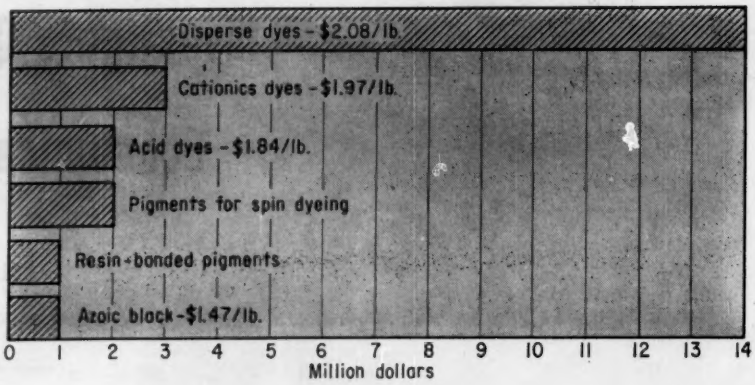
In Japan:
F. Kanematsu & Company, Ltd., Tokyo

Cotton (easily still king of all textiles) and viscose rayon, both using the same type of dyes, take the majority of all dye output—directs, vats, sulfurs, azoics and basics. Though regenerated cellulose fiber can be dyed like cotton, dyeing other synthetic fibers with these colors is often impossible.

So it is a new assortment of colorants that is profiting by the rise of synthetics: disperse dyes, cationic dyes (basics), acid dyes, pigments for spin dyeing, resin-bonded pigments.

Synthetic fibers took these colorants in 1960


Disperse dyes - $2.08/lb.
Cationics dyes - $1.97/lb.
Acid dyes - $1.84/lb.
Pigments for spin dyeing
Resin-bonded pigments
Azoic black - $1.47/lb.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Million dollars

▶ **Disperse Dyes**—Of the $25-million/yr. market for colorants in synthetic fibers, about $14 million is for disperse dyes. Estimates for 1970, $20 million.

Currently, disperse dyes account for just about all polyester-fiber coloring, 25% of acrylic coloring, 85% of the nylon colored for textile use. These three applications account for something over $4 million of the current market, with the rest made up by use on cellulose acetate fiber. But future growth is expected to be in the noncellulosic fibers, with the percentages of disperse-dye use within each fiber group remaining about the same. Production of cellulose acetate fibers has dropped 10% in the past decade. What's worse for dyes, the one acetate market that has been booming—cigarette filter tips—takes no color.

On the other hand, the colored segment of nylon in textile use alone is expected to go to something like 150 million lb. by 1965, whereas total textile use in 1961 is placed at about 50 million lb. Chemstrand has predicted that acrylic fiber sales will go to 234 million lb. in 1965, from 135 million in 1959; polyesters will go to 190 million lb., from 77 million.

Based on this 16.3% spurt of growth for polyesters, plus their dedication to disperse dyes, one dye manufacturer allots all growth of disperse dye through 1963 to polyesters.

Over the long run, however, total volume of acrylic fibers is expected to continue greater than polyesters' because of the greater number of acrylic fiber modifications and greater variety of textile end uses. Despite the fact that only 25% of its dye use will be in the disperse column, the market is expected to grow from close to $.9 million/yr. in 1960 to $2.5 million in 1970.

Some difference of opinion obtains in projections for the polyester and nylon markets in 1970. These projections range from $5-7 million for use of disperse dyes in polyesters, up from almost $1.8 million. For nylon, the range is $4-6 million, up from about $1.5 million. Producers identified with this class of dyes include Tennessee Eastman, General Aniline & Film, Du Pont, Ciba, Koppers.

The disperse dyes were originally developed for use on cellulose acetate, which has little affinity for the older classes of dyestuffs. Some very slightly water-soluble colored materials, which are chemically basic in nature, transfer to this fiber from a water suspension if the colors—mainly azo and anthraquinone pigments—are very finely divided particles. This results in a solution of dye in the fiber.

In addition to disperse dyes' basic attraction—simply that, unlike most other classes of colorants, they could be adapted effectively for use on the new synthetics—they are relatively easy to apply. However, difficulty of dyeing the various synthetic fibers increases in roughly the same order as their commercial introductions: cellulose acetate, nylon, acrylics, polyesters.

For cellulose acetate, the dyeing process involves immersion in the water suspension, diazotization and developing steps. Disperse dyes are used for nylon where maximum freedom from streaks (e.g., in hosiery) is essential. Acrylic fibers are dyed in light shades with disperse dyes at high temperatures. Polyester fibers are dyed at high temperatures or by the use of swelling agents and carriers* i.e. salicylic acid, chlorinated solvents.

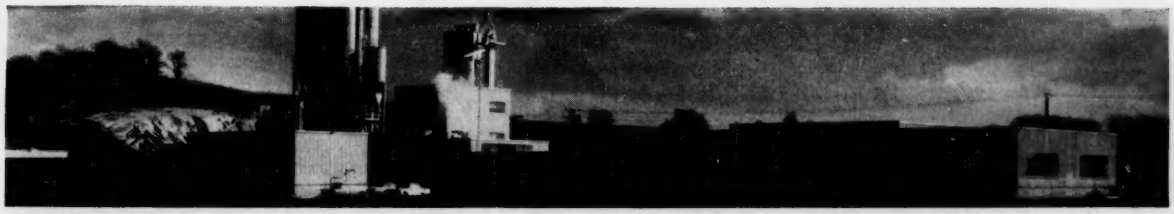
▶ **Cationic Dyes** — Cationic dyes' star has been rising with acrylics'. Holding 75% of the acrylics market, their usage is estimated at $3 million in 1960, $7.5 million in 1970.

These dyes are salts of organic bases containing amino or imino groups. The colored base is combined with a colorless acid, such as hydrochloric or sulfuric, and in solution the dye structure is in the cation. Being negatively charged, the acrylics are most successfully dyed to heavy hues with these positively charged colorants.

▶ **Acid Dyes**—Acid dyes account for most of the 15% of the nylon coloring market not served by disperse dyes. And most of their $2 million total use in synthetic fibers is in nylon.

These dyes are salts of organic

* Swelling agents open up the fiber structure temporarily so dye molecules or aggregates may enter more freely and come in contact with otherwise inaccessible dyesites. Carriers accelerate dyeing by breaking up or dissolving dye aggregates and bringing them to the fiber-water interface in a size small enough to be absorbed by the material.



NEW AUTOMATED CONCRETE PLANT CHOOSES LOUISVILLE FLUIDIZED BED DRYER

General American's Louisville Fluidized Bed Dryer was the choice for drying silica sand when Durox of Minnesota, Inc., installed a coordinated materials handling system at their new Lake Elmo, Minnesota plant.

Says Eugene A. Kraut, vice president and general manager: "We chose the Louisville *Fluidized Bed* Dryer because it is almost entirely maintenance free, fits best into an automated system of materials handling and accommodates a wide variation of throughput".

Durox of Minnesota makes light weight cellular concrete shapes by a patented process. The function of the dryer is to reduce the moisture content of silica sand from an average of 8% when mined to 0.5% before it is stored for blending with lime, cement and other ingredients.

Equipment engineered, fabricated and installed by General American's Coordinated Equipment Division is used for preparing, handling, weighing and blending the ingredients used in the Durox process. For details of the fluidized bed dryer, ask for Bulletin #FBD-61. For information on other coordinated equipment, please write.

Process Equipment Division—Louisville Dryers

GENERAL AMERICAN TRANSPORTATION CORPORATION

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acids; the acid group confers solubility on the dyestuff molecule. When dissolved, the dye ionizes with the dye structure in the anionic part. This class of dyes also finds substantial use on wool and natural silk.

▶**Resin-Bonded Pigments**—In textiles, pigments have surged fastest in printing. Tailor-made resins have been developed along with processes that bond the insoluble colored pigment to the cloth. For pigments in this application, a total market of about $15 million/yr. has been built in the past 15 yr.; 20% is now for synthetic fibers, the rest is for cotton.

Use in synthetic fibers is expected to increase by about $500,000 by 1965, all on noncellulosics. The problem of rubbing off, or crocking, has limited these applications but has now been overcome to a large extent. However, most growth is expected for pad-dyeing of pastels, which do not present much of a crocking problem.

▶**Spin Dyeing**—Spin dyeing is the homogeneous mixing of the synthetic-fiber raw material with pigment dyestuff—as a rule, immediately before entering the spinning jets. Used for years for rayon and acetate, they still represent about 70% of this end use.

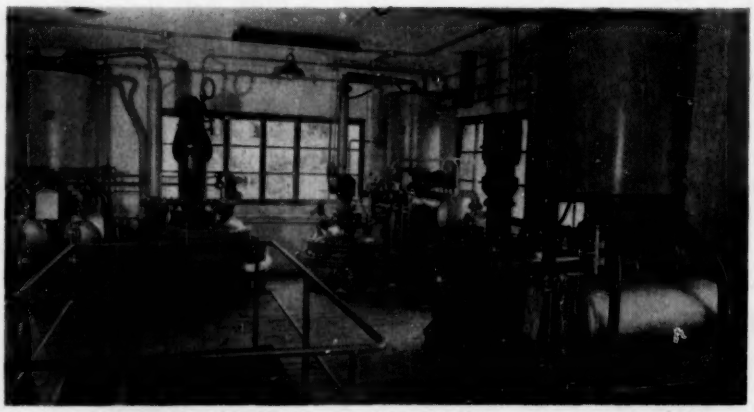
Current market is variously estimated at between $1.2 and $2 million/yr., is expected to grow about 40% in the next five years. Limiting growth: Spin dyeing ties the processor down to large lots of certain colors. With the rapid changes in fashion nowadays, coupled with short supply dates, it is desirable to apply the dyestuff to the fiber as late as possible, preferably after the weaving process. Also, pigment particle size adapts better to heavy denier fiber than to fine denier. The relatively standardized color combinations and heavy denier fibers of such applications as auto and outdoor seat covers seem to offer promise for this method.

The polyolefins, including polypropylene, can be colored in this way. However, high processing temperatures of linear polyethylene and polypropylene rule out use of heat-sensitive organic pigment. Over-all, 60% of the pigments used in spin dyeing are inorganic.

▶**Polypropylene Problem** — Research on polypropylene dyes is widespread. Some experts peg disperse dyes as good possibilities, but note that unconventional processing may be necessary.

The practical solution may be in the area of making the raw fiber more dyeable, by modifying either polymer or fiber in combination with a specific selection of dyestuffs. Incorporation of dye-receptive materials in the polymer by copolymerization, or in the form of additives, is a likely commercial approach.

Although working with existing dyes is the obvious first approach—and undoubtedly the best, if it pays off—the dyeing problem can be attacked in several ways. Irradiation, for instance, is being used in laboratories, both to cross-link polypropylene and to graft dye-receptive monomers onto the polymer chain.—FA



Ledoga's pilot plant had daily capacity of 200-lb. esters and glycerides.

SUCROSE ESTERS KICK OFF SUGAR'S NEW CHEMICAL FLING

Bolstered by successful pilot runs and government approval, Italian firm plans commercial production of both esters and glycerides.

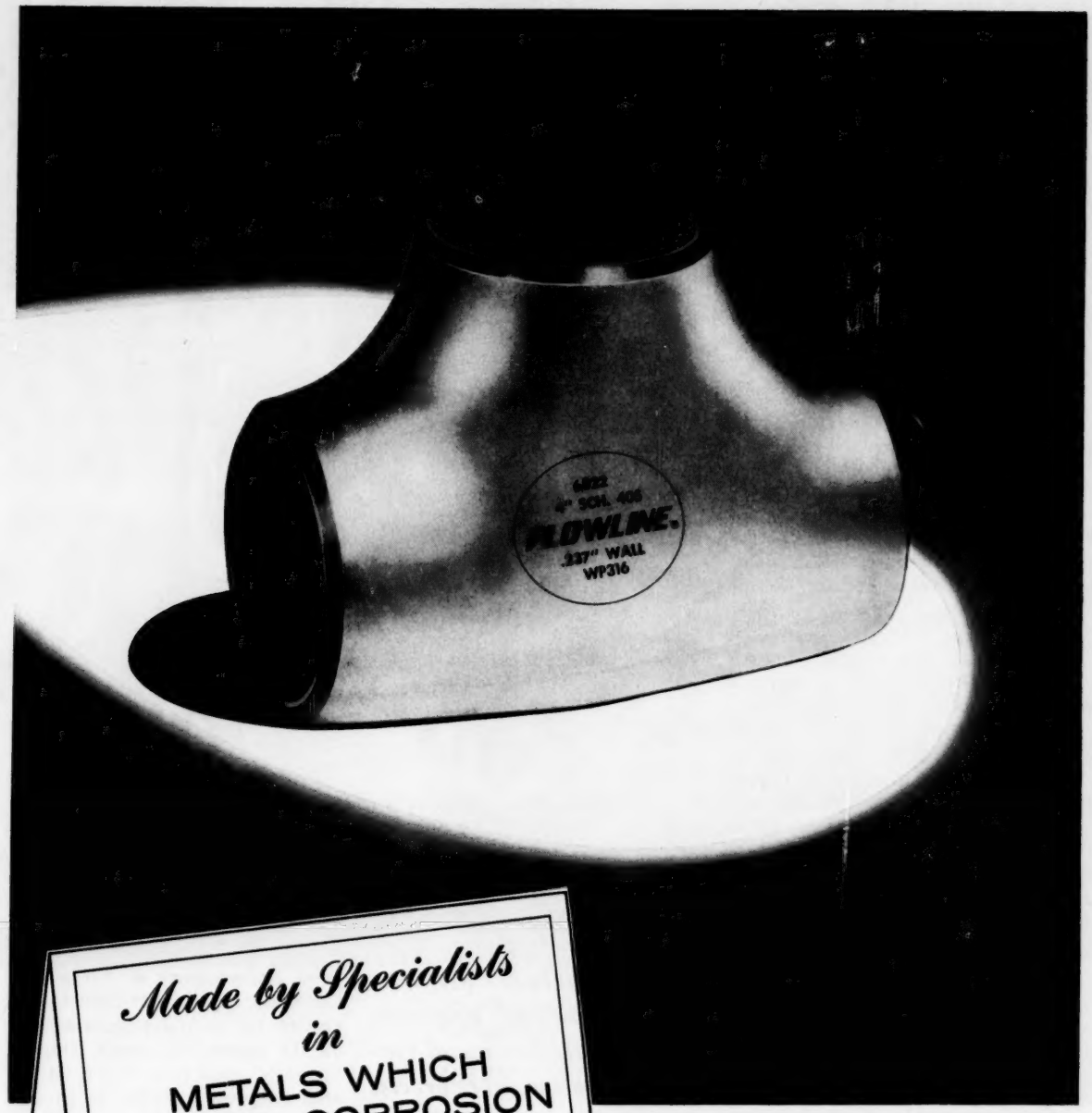
Sucrose esters, those sugar-base emulsifiers that made headlines a few years ago, are in the news again.

The reason: announcement by Ledoga S.P.A., Milan, large Italian drug and chemical firm, of its intention to build plants in Jamaica and Brazil for the commercial production of sucrose esters and glycerides.

Ledoga is presently making limited quantities of these products in a 200-lb./day pilot installation at its Garessio, Italy, plant. The company obtains the pure esters by transesterification of the methyl esters of fatty acids with sucrose. The sugar glycerides are made by treating a natural fat instead of fatty acids.

With its processes, Ledoga claims to have overcome toxicity, one of the problems that has interfered with development of the sugar detergents as food additives. Apparently substantiating this claim is the approval by the Italian government of use of sucrose esters in foods.

This has opened the door to their use as emulsifiers in breads, pastries, candies and ice cream. Also, in dentifrices, shaving prepara-



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tions, soaps, detergents and pharmaceuticals.

Ledoga maintains that the price of its sugar glycerides (reportedly 50¢/lb.) is low enough to justify their use in leather, furs, textiles, animal feeds and insecticides.

▶**How It's Made**—Basic process for the manufacture of sucrose esters was developed by L. I. Osipow of Foster D. Snell, Inc., New York, and a patent was issued to Sugar Research Foundation (U. S. 2,893,-990).* Last November, SRF assigned the patent rights to Research Corp., New York.

Crux of the process is the reaction of sucrose with methyl esters of fatty acids in a solvent. Potassium carbonate is used as a catalyst. Preferred solvent is dimethyl formamide.

An excess of sugar yields the monoester, for detergent use. An excess of fatty ester produces a diester for food use.

Big problem encountered in the manufacture of the esters was removal of residual dimethyl formamide, which is both irritating and toxic. Ledoga has apparently found an economical way of accomplishing this.

▶**Other Producers, Too**—Although Ledoga seems to be the only company planning commercial production of sugar esters at this time, there are several other firms that have been licensed by SRF. Some of these are now making pilot quantities of the products.

In the U. S., The Colonial Sugar Co., Gramercy, La., is offering pilot-plant quantities of sucrose esters in two grades—technical and refined.

In Japan, Dia-Nippon Sugar Mfg. Co. is producing sugar esters from sucrose and a high-purity stearic acid. Its product, called Nitto Ester, has been approved as a food additive by the Japanese Welfare Ministry.

The following are also licensed to make the esters: Howard of Ilford, Ilford, England, and Societe de Produits Chimique de Synthese Bezons, Seine et Oise, France.—AVG

* In additional research, sponsored by the National Renderers Assn., Snell has prepared such esters as sucrose oleate, palmitate and stearate, all of which are efficient detergents.

Process quickly converts oversize forging to desired shape.

ELECTROLYTIC MACHINING SPEEDS METAL SHAPING

New technique performs difficult milling operation without metal-to-metal contact. It's faster, more precise than conventional machining methods.

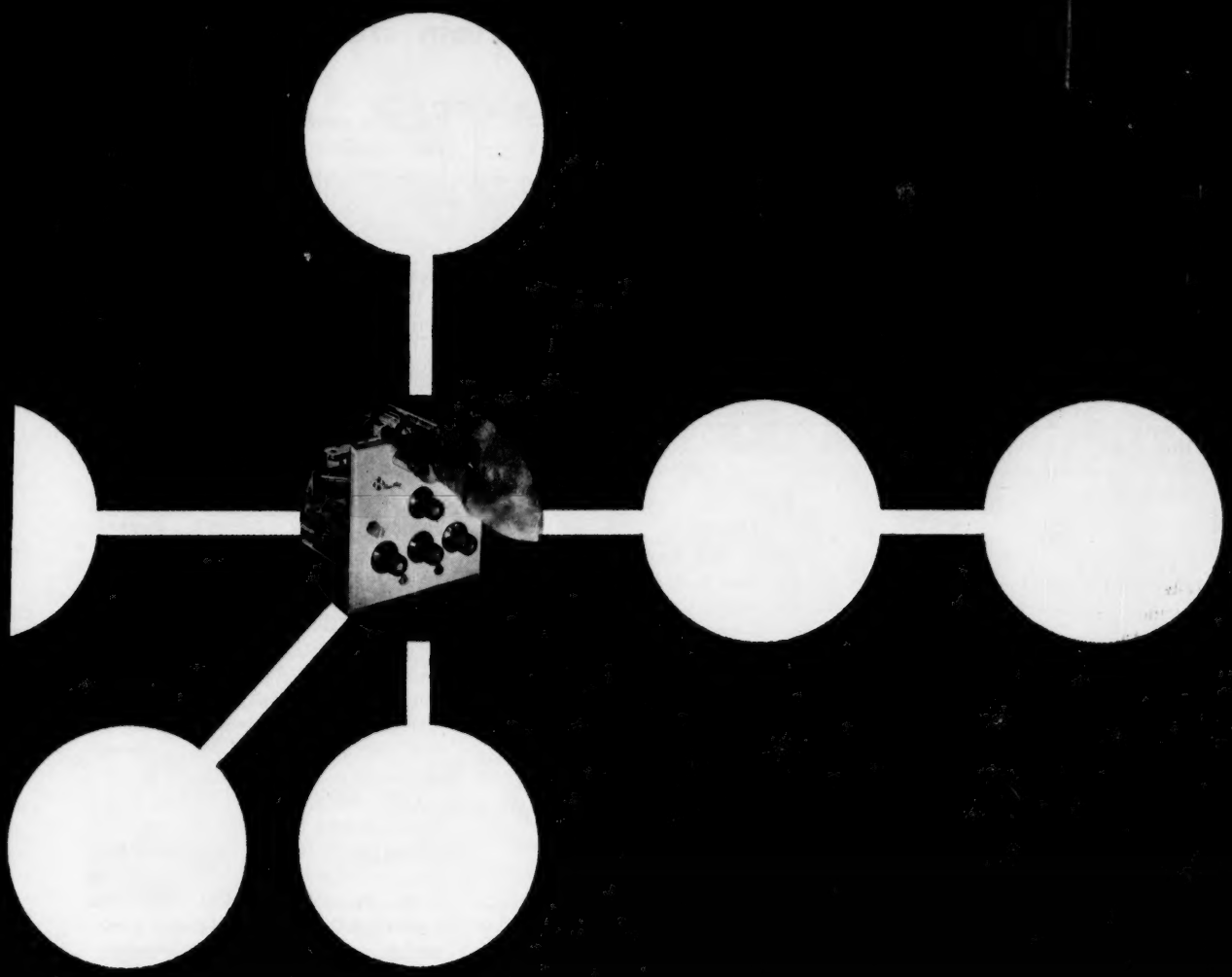
Wraps have recently been removed from a new chemical milling process for shaping difficult metal parts, having greater dimensional accuracy and speed than by conventional casting, rolling, forging or machining methods.

Its effectiveness is not dependent on the hardness of the metal and, thus, is said to offer a solution to machining such high-strength alloys as S-816, Nimonic, Udimet 700, Waspalloy, etc.

Researched for 2½ yr. at Battelle Institute under sponsorship of Steel Improvement & Forge Co., Cleveland, process has been in operation for several months at one of the company's plants. During this time, more than 15,000 jet engine compressor blades, in 16 different designs, have been successfully produced.

The approach followed by Sifco has been to produce a slightly oversize forging, allowing a band of material for subsequent removal by electro-chemical techniques. However, company officials say the new process is also applicable to castings or bar stock.

▶**Uses Shaping Electrodes**—Unlike Turco Products' "Chem-Mill" process (*Chem. Eng.*, July '54, p. 140), in which the metal is first masked, followed by demasking of the surfaces to be milled, the new technique, called "Sifco Shape," employs electrodes made in the size and shape to be duplicated.



COMPUTER CONTROL?

easy—when the controller is a computer

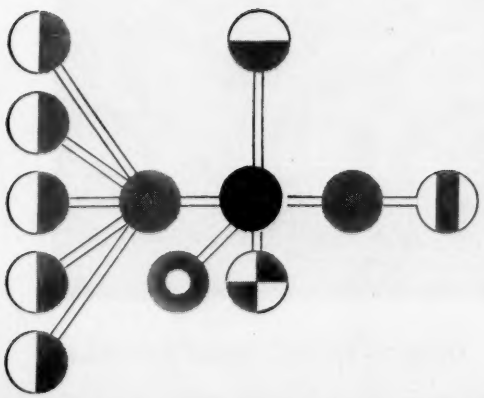
Hagan's PowrMag system is based on the analog computer approach to process control. The core of the system is the controller, and the core of the controller is an *operational* magnetic amplifier. Potted and encased in steel, this high gain amplifier can produce all control actions by means of simple negative feedback through ordinary resistive or capacitive components. These "passive" components are interchangeable and are easily plugged into the basic amplifier chassis by means of an integral plug board.

The basic controller can thus provide functions required for each control loop—addition, subtraction, gain, rate action or integration.

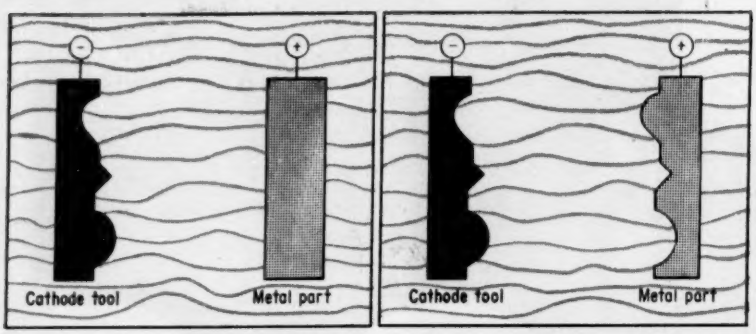
This modular construction reduces inventory problems, and provides a high degree of flexibility. Since the system uses high level DC voltages, noise, capacitive loss and phase shift problems are eliminated. Power consumption is low—about 3.5 watts per unit, and the power supply is unregulated 110v AC.

The control information center consists of a man/auto control station with set point, bias or ratio, integrally mounted controller, with an associated miniature strip chart recorder.

Hagan's PowrMag system was designed to supplement existing systems (it is compatible with any DC electronic system) or to be designed into complete, new systems. For information, write or phone HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Pittsburgh 30, Pa. Telephone WAlnut 2-3737.



HAGAN



How Sifco Shape operates. Left: shaped electrode and rough work piece are placed in plastic chamber with electrolyte. Right: finished piece has assumed shape of electrode.

Work piece and electrodes are placed in a plastic chamber. Then, an electric current is passed from work piece (anode) to the electrodes (cathodes) through a rapidly moving electrolyte.

As the operation progresses, electrodes are moved closer together so that the work piece is gradually "worked-in."

Rate of metal removal is governed by amount of electric current applied, and varies with type of metal and work area.

Of equal importance is flow of electrolyte past surface being machined. Its movement should be rapid enough to support an electric current flow of 1,500 amp./sq. in. without boiling. In actual operation, however, 200-500 amp./sq. in. are generally used. These flows result in removal rates of 0.50-0.10 in./min.—AVG

NEW PROCESSES ADD FLAVOR TO CAPROLACTAM PRICE STEW

New toluene-based route to caprolactam is Allied's answer to the challenge of Du Pont's unique cyclohexane process.

The recent publication of Belgian patent 582,793 has rekindled a controversy that has been debated among chemical companies for the past few years: What is the cheapest way to make caprolactam, the monomer for nylon-6?

Du Pont maintains that its newly developed process, based on cyclohexane, is the most economical. Allied Chemical, whose National Aniline Div. is now the only major caprolactam producer, has claimed that its phenol-based process is competitive with the newer cyclohexane route.

But in a move obviously designed to maintain its competitive position, Allied is hedging its caprolactam bet with a new toluene-based process licensed from Italy's Snia Viscosa. Allied is now nearing completion of a new plant utilizing the Snia process at its Hopewell, Va., complex. Although few details have been revealed about the new route, the Belgian patent referred to above contains the first published description of the chemistry of the process.

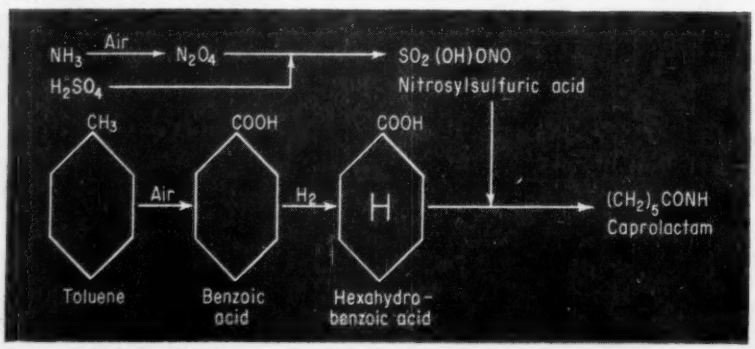
Du Pont's cyclohexane process is being used in a new 50-million-lb./yr. plant at Beaumont, Tex., that is now going through the throes of startup. When it comes into full production in about six months, it will make Du Pont the second major caprolactam producer. The firm has promised to sell its product below present market prices.

▶ **Getting It Cheaper**—Main advantages of the Snia Viscosa process: (1) toluene starting material is cheaper than either phenol or cyclohexane; (2) flowsheet requires fewer steps than phenol route; (3) production costs are only about one third those of the phenol process.

Courtaulds, Ltd., one of England's largest fiber makers, has also licensed the Snia process, but has not announced any construction plans. Meanwhile, Snia Viscosa has its own full-scale caprolactam plant under construction at Torviscosa, near Trieste, after eight years of process development at its pilot plant north of Milan at Cesano Maderno.

Little is known about Du Pont's cyclohexane route, other than it is claimed to be considerably cheaper than the phenol process used by Allied. In the Allied process, phenol is first converted to

Nitrosation: key to Snia Viscosa caprolactam route



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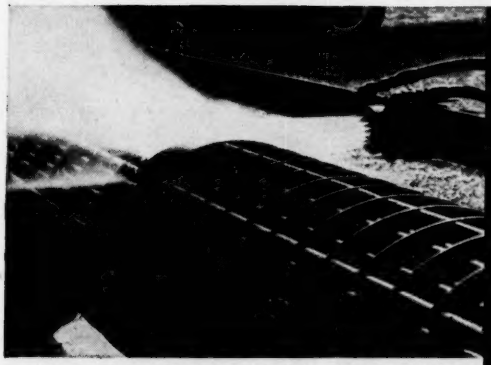
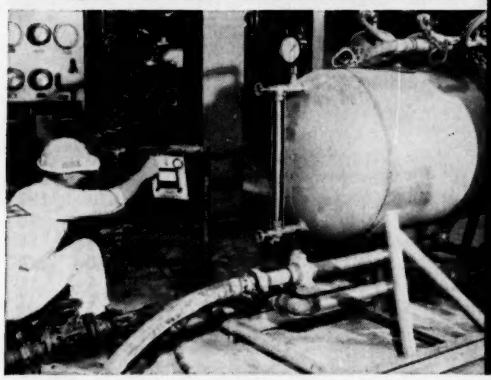
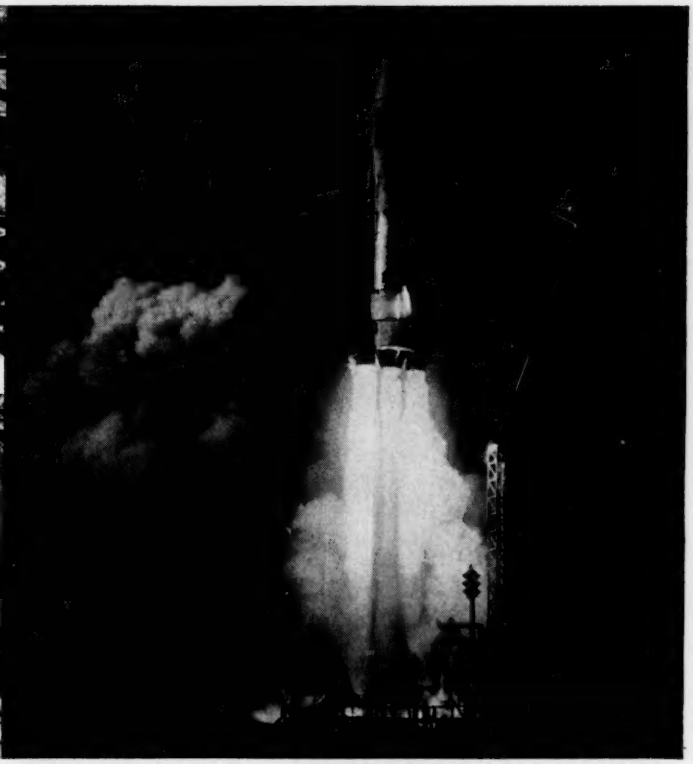


Jetting tool cleans tubes fouled with coke and asphalt.



New mobile foam-cleaning equipment cuts cleaning costs.



Cleaning missile lines and components requires tolerances as close as 150 microns.

DOW INDUSTRIAL SERVICE

Industrial Cleaning. Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

Product Sales and Service. The sale of specialized chemical products, scientifically formulated to be of use in specific industrial processes and to give the necessary technical service in their use, is the job of Product Sales and Service. Purifloc* N17 is an outstanding new flocculant cleared by USPHS for use in potable water.

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You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio. *TRADEMARK

DOW INDUSTRIAL SERVICE DOW *Division of THE DOW CHEMICAL COMPANY*

cyclohexanol, and then to cyclohexanone. This is reacted with hydroxylamine to form cyclohexanone-oxime, which is then converted to caprolactam with oleum.

▶ **Cyclohexane Alternatives**—It is possible to start with cyclohexane and convert it to cyclohexanol, then follow the same processing sequence as in the standard phenol-based flowsheet. But most observers believe that in order for Du Pont to make its claims for a more efficient process, it must have evolved a direct-oxidation route that eliminates several of the intermediate stages. Du Pont has been granted several patents in this area and it's probable that its new Beaumont plant is built around these patents.

Commercial Solvents says that it also has a cyclohexane-based caprolactam process, now in advanced pilot stage at Terre Haute, Ind.

With Du Pont's announced intention of selling caprolactam at lower prices, Allied's new toluene process should give the firm some maneuvering space if a round of price-cutting develops during 1961. And end uses of nylon-6—mainly fibers and molded products—should be stimulated by any lower prices that are brought on by the increased competition.

▶ **Starting with Toluene**—According to the patent, the Snia Viscosa process starts with toluene, which is oxidized with air to form benzoic acid. This is then treated with hydrogen to form hexahydrobenzoic acid. Next comes the nitrosation reaction that forms the crude caprolactam.

Several nitrosation reagents can be used. Among those cited in the patent are nitrosylsulfuric acid, nitrosyl chloride and nitrogen monoxide. Most practical reagent to use on a commercial scale is nitrosylsulfuric acid, which can be prepared by oxidizing ammonia to dinitrogen tetroxide, then reacting the N_2O_4 with oleum to form the nitrosation acid. This reagent, besides being the most economical to manufacture, also has the advantage of containing sulfuric acid, which is needed in the nitrosation reaction.

Mole ratio of the hexahydrobenzoic acid and nitrosylsulfuric is preferably between 3:1 and 1:1. Preferred reaction temperature is 120-390 F. at atmospheric pressure.

The reaction, under proper conditions is almost instantaneous; yields can range from 90-100% of theoretical. Crude caprolactam from the nitrosation reaction must then be purified.—RAL

ORGANICS ON THE MOVE IN JAPAN

How much *sec*-butanol will be produced in Japan during the year 1970? How about pentaerithritol? Or polyvinylchloride?

Bold extrapolations of '55-'59 statistics in Japan's heavy-organics industry (*Chem. Eng.*, Feb. 6, p. 54) have been made in a paper by A. M. Griswold, vice president of Dow Chemical International, and Shiro Ishihara, manager of research for Japan's Asahi Chemical Industry Co., delivered at the AIChE New Orleans Meeting on Feb. 26-Mar. 1. Here are highlights:

Japan's CPI is definitely shifting into petrochemicals: "All ethyl alcohol is now made by fermentation. It is assumed that by 1970 it will all be made synthetically. The coming tendency to shift from an acetylene to an ethylene route is illustrated by the 1965 and 1970 estimates for the production of acetaldehyde and of ethylene dichloride used mainly for vinyl chloride. These raw material shifts characterize the change to a petrochemical economy."

Current shortage of capital is forcing near-capacity operations: "In Japan, there is [now]a shortage of capital with resultant high interest rates. . . . Thus, plants must be operated at a relatively high percentage of capacity to keep the capital charges within bounds."

A sampling of the paper's production and consumption forecasts:

• Petrochemical consumption (in 1,000 metric tons/yr.):

Product	1960	1965 (M tons)	1970
Ethylene	84	320	510
Propylene	25	240	470
Benzene	130	240	370
Butylene*	49	190	360
Xylene	52	120	190
Toluene	56	100	140

Most startling — and probably most reliable—are the orders of magnitude of the predicted consumption increases.

• On the opposite side of the coin, production figures of a few selected petrochemicals are estimated to be (again in 1,000 metric tons/yr.):

Product	1960	1965	1970
Polyvinylchloride	280	450	600
Polypropylene	...	46	200
Butadiene	27	100	200
Polyethylene	45	120	190
Nylon	40	58	75
Acrylonitrile	20	44	61
Polyurethane	1	10	25
Epoxy resins	...	4	10

The standout performer, evidently, is expected to be polyvinylchloride—whose production curve spurts diagonally up and off the graph.

But keep an eye on polypropylene, too—which starts its upward zoom from a zero base.

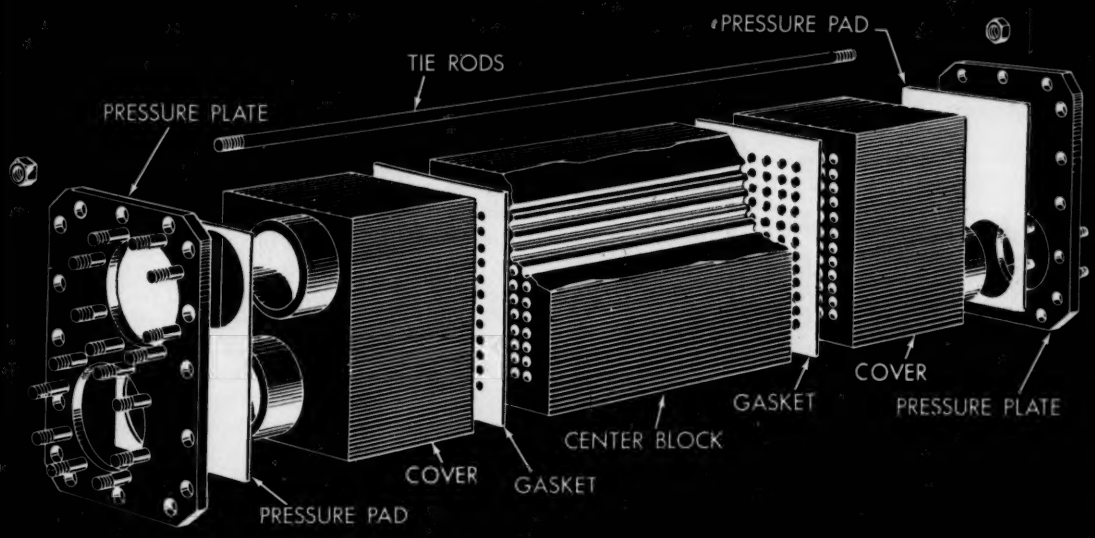
Perhaps the real meat of the Griswold-Ishihara paper, though, is found in a discussion of overcapacity and its implications on export trade. For example, "At present there are five polyethylene plants in Japan. . . . The total rated capacity of these five plants is 52,000 metric tons/yr. . . . If all of the present plans for additional polyethylene capacity were approved and the plants were built, the total capacity would be 302,500 metric tons/yr. Contrasted to this, the current estimate for polyethylene production in 1970 is 190,000 metric tons."

The big question: what do you do with all that extra capacity?

Answer: export it. (*Continued*)

* "Butylene estimates should be inperpreted as the butylene equivalent of butylene, butane, and of butadiene extracted directly from cracked hydrocarbon streams."

Announcing the NEW...



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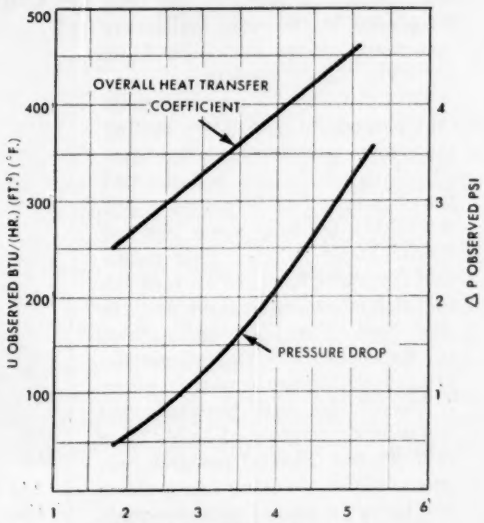
- **Unsurpassed corrosion resistance**—fluids on both sides of this exchanger contact "Karbate" impervious graphite only.
- **High thermal efficiency**—true counterflow design provides most effective use of available temperature differential with minimum pressure drop.
- **Compact design**—only 13 inches x 21 inches in cross-section; when installed vertically the unit provides more heat transfer area per square foot of floor space than any other block type exchanger.
- **Heat transfer area easily changed**—the number of 23-inch-long center blocks can be varied from 1 to 6 to provide a range of areas (for 3-pass unit) from 37.3 to 172.8 square feet.
- **Rugged construction**—sturdy, impervious graphite blocks assemble into single or multi-pass units, operating at pressures up to 100 lbs. per square inch.

For details, write for **Catalog Section S-6813** Address: National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.



TEST DATA FOR TYPE CFB HEAT EXCHANGER
(3-PASS—ONE CENTER BLOCK)

Graph shows typical overall heat transfer coefficient and pressure drop test data for a water-water system in a "Karbate" impervious graphite single center block, 3-pass (both sides), Type CFB heat exchanger.

"National," "Karbate" and "Union Carbide" are registered trade marks for products of

NATIONAL CARBON COMPANY

UNION CARBIDE

And this is how the authors conclude their report. "It would seem likely that with [Japan's] imperative need for exports, the future will find her more active in world chemical markets."

Pulpers Disclose Progress In Pollution Control

As representatives of the paper industry were gathering in New York last month at the annual meeting of TAPPI to discuss ways of improving paper production, the National Council for Stream Improvement was describing the progress the industry has made in cutting down pollution.

The council's annual report, which points out the strides that have been made in pollution control, is especially timely because of mounting pressures from conservationists and other groups to eliminate all sources of stream pollution. In Washington state, for example, where oyster growers have already promoted legislation to limit stream pollution (*Chem. Eng.*, Dec. 12, 1960, p. 78), a new bill has been introduced in the state legislature that would charge pulp mills $1.00 for every ton of effluent.

To illustrate the achievements that pulpers have made in cutting the stream pollution load, the council points out that while paper and board output has increased 100% since 1943, the total waste load has been reduced by 2%. This means that the waste from the average ton of output has been cut by 51% in that time. The industry has also cut its use of water by 50% per ton of product during the past 16 years.

One of the main problems still unresolved: removal of solids from mill effluent. Several research programs aimed at curing this problem are being sponsored by the council. In one mill test, a disk centrifuge was able to recover as much as 97% of the solids from board mill sludge. Among other methods for solids disposal under investigation: burning dewatered sludge in existing furnaces.

Other studies are aimed at reducing the BOD (biochemical oxygen demand) of effluents. One of the most promising approaches is the adaptation of standard activated sludge processes to mill wastes. Tests have shown that substantial BOD reduction is possible with most wastes by using retention periods of 4 hr. or less. Rate of oxidation is higher than that obtained with ordinary municipal sewage because of the higher temperatures involved and improved sludge-effluent contacting methods. Major problem remaining is disposal of the treated sludge.

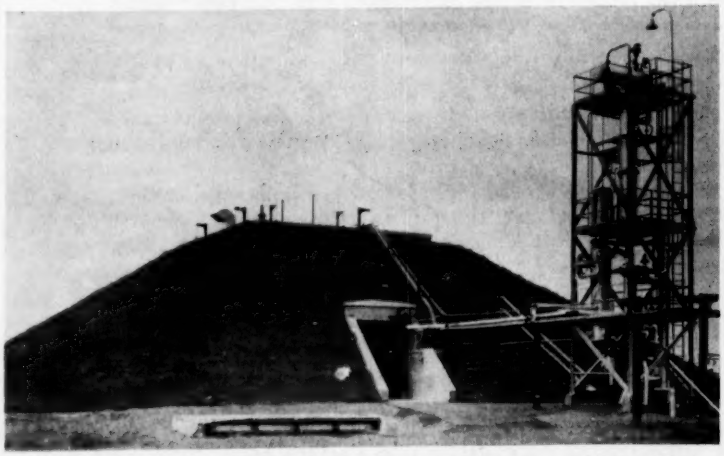
Japan's AEC Maps 20-Year Plan for Atomic Progress

The atomic energy commission in Japan last month formally adopted a long-range energy development and utilization program calling for generation of 1 million kw. of electric power from nuclear reactors by 1970. By 1980, the commission looks for 7-9.5 million kw. to come from atomic power plants.

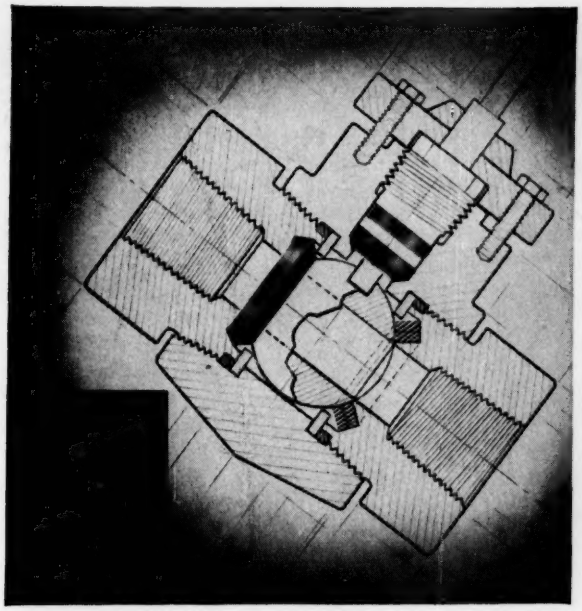
Japan's second atomic reactor is slated to be a light-water-cooled unit using enriched uranium fuel. Japan's first reactor was a Calder Hall type employing gas cooling and natural uranium. For the third and following reactors, designs are expected to alternate between the two models. Other aspects of the 20-year program call for:

- Promotion of the use of radioisotopes in manufacturing processes, agriculture and medicine.
- Construction of the first Japanese nuclear-powered ship between 1968 and 1970.
- Development of nuclear fuel resources overseas as well as development of technology for enriching uranium and utilizing plutonium. This program will be in addition to Japan's exploitation of its domestic sources of natural uranium.
- Budgeting of $500-$555.5 million during the next 10 years for

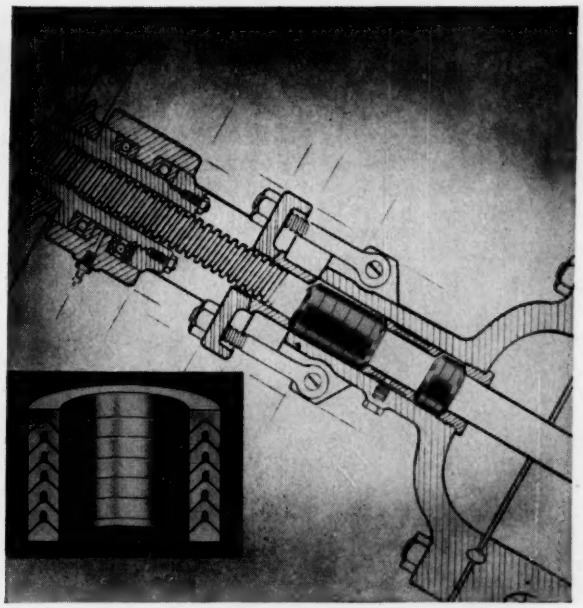
Under these tons of earth is a modern explosives plant



The pyramid-shaped mound of earth is covering one of the two buildings that comprise Canadian Industries Ltd.'s new PETN (pentaerythritol tetranitrate) plant at Beloeil, Que. Each building, one for production of crude PETN and one for refining the product, is covered with 4,000 tons of sand, topped with sod, to mitigate the danger from a possible explosion. To the right of the refining building shown above is a distillation column for recovering acetone, one of the plant's raw materials. The other two feedstocks are pentaerythritol and nitric acid.



Seats and stem gaskets of TFE resin assure tight-sealing, no-stick operation in these non-lubricated ball valves used in high-pressure butane-propane service. These valves have been in operation for three and one-half years, with no leakage or valve failure.



V-ring packings of a TEFLON TFE resin in valves for paper-mill service eliminate the frequent changes of packing and periodic adjustments formerly required. In addition, losses of corrosive liquor are eliminated and wear on valve stems is sharply reduced.

Maintenance and replacement costs reduced with packings and gaskets of TEFLON® TFE resins

The two examples above typify the cost-cutting advantages of TEFLON fluorocarbon resins as packing and gasket materials. In all applications TEFLON resins provide long service life . . . with resultant savings in maintenance and replacement costs, plus increased productive capacity due to less downtime. TEFLON resins are not affected by materials being processed. Their low-friction characteristics often permit their use without lubrication, minimize torque requirements, and reduce wear on pistons and shafts.

TFE resins are the established standards where reliability over a wide range of severe conditions is important. They are rated for continuous service at 500°F. FEP resin is the new melt-processible member of the family of TEFLON fluorocarbon resins. It can be molded and extruded like nylon, polyethylene and other familiar resins. FEP resin is capable of continuous service at 400°F.

In many applications, TEFLON fluorocarbon resins have been found to be the only material that would give satisfactory performance. But even when service demands are not exceptionally rugged, the properties and versatility of TEFLON TFE and FEP resins permit plant-wide standardization for packings and gaskets in chemical service.

For more information about the wide variety of forms in which TFE and FEP resins are available for sealing applications, consult your supplier. And for additional information about properties and characteristics of TEFLON resins and the many ways they have led to improved, economical designs, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department CE-320, Room 2526T, Nemours Building, Wilmington 98, Delaware.

• • •

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

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TEFLON®

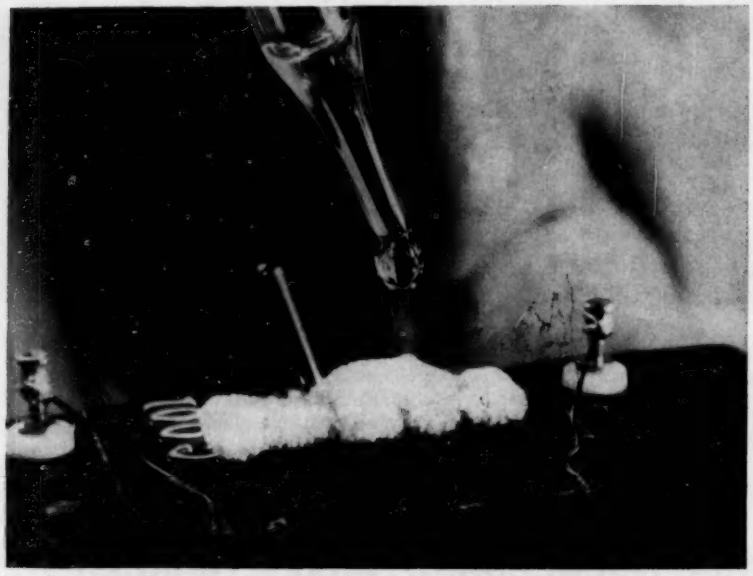
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

atomic energy research and for increasing the number of atomic scientists and engineers to around 13,000—twice the present number.

• Inauguration of a public-safety screening program for all nuclear reactor designs and a state inspection system for nuclear plants, to insure safe operation of all reactor stations.



Developed by Hughes Aircraft, improved thermoelectric unit freezes water by using current from small batteries. Reversing the current melts ice.

THERMOELECTRICITY HEATS UP

A device the size of a paper clip can freeze water—and then bail it—on the power from two flashlight batteries. But that's just one of several recent thermoelectricity developments.

Among the latest:

• The thermoelectric device described above based on the Peltier effect,* was developed by Hughes Aircraft, Culver City, Calif. Possible applications range from constant-temperature maintenance in spaceships to instant-defrost refrigerators.

Up to now, Peltier-based thermoelectric units had been impractical because of their large power requirements (20 to 30 amp.). Hughes solved the problem by a new technique of fabricating the thermoelectric material so it could operate at 1/10 the usual current.

Hughes has demonstrated unit's practicability by two multi-celled models: a three-stage cascaded cooler that takes only 2 amp. to cool an infrared detector down to − 100 F., and a heat-controlled oven that needs less power than an automobile headlight to maintain 70 F. at temperatures varying from 180 F. to −40 F.

• Another thermoelectric unit is the aim of an 18-month program just started at Minnesota Mining & Manufacturing Co., St. Paul. Eleven gas untilities have joined with 3M to design preproduction prototypes of a thermoelectric furnace-generator.

This instrument would convert heat from furnace combustion chambers directly into electricity—the reverse of Hughes' electricity-to-heat route. But the technology is similar. A "proof of principle" furnace-generator has already been incorporated in a conventional gas-fired wall heater.

Main advantage of a furnace-generator like the one 3M is after: uninterrupted power for the furnace pumps and blowers.

• And a thermionic† converter is currently undergoing tests at General Electric's Vallecitos Atomic Laboratory, Pleasanton, Calif. Described as a plasma diode, the device converts high (4,500 F.) heat from the center of nuclear reactor fuel elements into electricity.

GE sees primary application in nuclear power plants, where the cesium-gap diode could boost plant efficiency by 10-20%. (However, since d.c. electricity is produced, there would be some conversion loss.) Device probably couldn't be adapted to conventional steam generators—their operating temperatures are too low.

Diode has operated only as long as a week before breaking down, which is about 1/50 the minimum required life for commercial application. Still, the company expects to have a diode ready for installation in a prototype plant by 1965 and in a commercial station by 1970.

* Direct conversion of electricity to heat or cold at a junction of two dissimilar semiconductors.

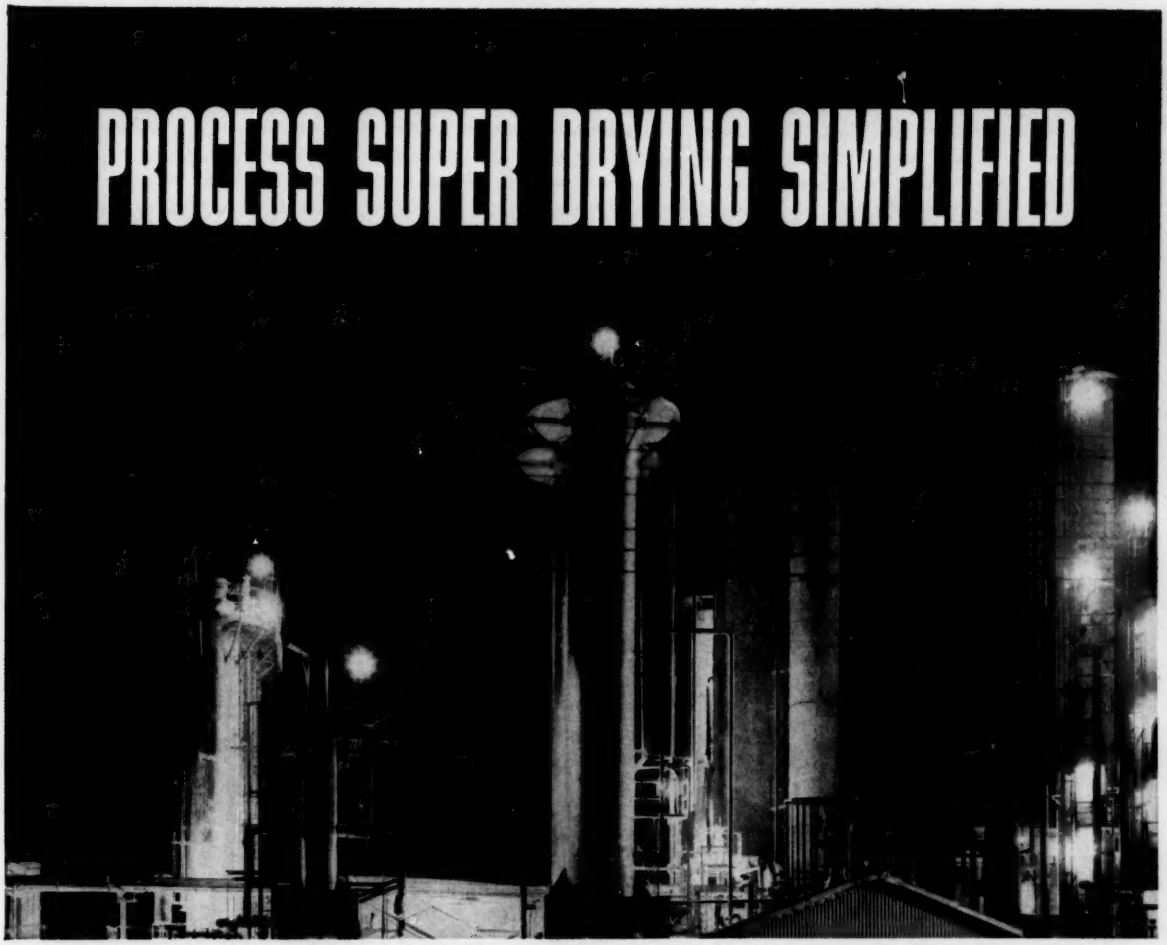
† Direct conversion of heat to electricity by boiling electrons off a cathode, collecting them on an anode.

Computer Program Slashes Stress-Analysis Time

Arthur D. Little, Inc., Cambridge, Mass., has just announced that it has developed a new computer program that drastically reduces the time needed by vessel designers to calculate stress effects on elastic shells. The program can be used on any shell that has rotational symmetry, such as pressure vessels, bellows and diaphragms.

The ADL scheme is designed for high-speed digital computers, will provide a complete deflection and stress analysis to vessels subjected to arbitrary loading or temperature distribution. For the program to apply, the shell must form a surface of revolution about some central axis, and the loading and tempera-

PROCESS SUPER DRYING SIMPLIFIED



MHI CALCIUM HYDRIDE drys materials completely in gas or liquid phase

Versatility, almost unlimited . . . effectiveness, process proved . . . MHI calcium hydride is simplifying today's "tough nut" complete drying problems! MHI calcium hydride is uniquely successful in those new processes where water *can't be tolerated.* Included are catalysis systems for polymerization, the preparation of refrigerants, aerosol propellants, pharmaceuticals, and nuclear reactor atmospheres. MHI calcium hydride has an unequaled ability to dry *completely* in unit processes involving gases, such as hydrogen, argon, helium, nitrogen, hydrocarbons, chlorinated hydrocarbons, esters, alcohols, and many other types of compounds.

HERE'S HOW IT SIMPLIFIES. Even at elevated temperatures where adsorbtive type driers are ineffective, MHI calcium hydride drys completely. Contact with MHI calcium hydride can be in stirred tanks, by percolation through a fixed bed of calcium hydride, or vapor phase through a fixed bed. Temperatures can range from below room temperature *up to 1400°F.* Contact times may be as short as a few seconds. Calcium hydride is safe and easy to use and store.

EFFECTIVENESS OF CALCIUM HYDRIDE FOR YOUR PROCESS EASILY PROVED. With your own titrimeter, you will see how MHI calcium hydride drys residual moisture down to dew points of less than —60°F or to one p.p.m. range. Metal Hydrides Incorporated will gladly provide samples upon written request.

NEW CALCIUM HYDRIDE TECHNICAL BULLETIN AVAILABLE. You may get details on complete drying with MHI calcium hydride by requesting your copy of this new bulletin.

PIONEERS IN HYDRIDE CHEMISTRY

Metal Hydrides Incorporated

304 CONGRESS STREET, BEVERLY, MASSACHUSETTS

ture profile must be symmetrically disposed with respect to this axis, The vessel must also be sufficiently thin so that the conventional elastic thin-shell method is applicable.

Following an engineering evaluation of the particular shell problem, subprograms describing the geometry, loading, and elastic properties must be prepared and boundary conditions arranged. Stresses and deflections are then printed out as output for preselected points along the shell.

JUNKMEN CUT DISPOSAL COSTS

A small firm in the town of Pendleton (near Buffalo), N. Y., has been operating for two years in a new and unusual field—processing industrial wastes for companies who previously dumped them into city sewers or streams.

One of a number of chemical "junkmen" that have recently sprung up, Frontier Chemical Process, Inc., is the brain child of two Buffalo lawyers, Thomas J and Ross L. Runfola, and Harold V. Schultz, a self-styled practical chemist. About five years ago, they sensed the trend to pollution control legislation, and spent some three years developing satisfactory types of treatment for the various wastes in the Niagara Frontier area.

Handling only liquid wastes from chemical processing operations, Frontier operates in an abandoned clay pit that has a 17-acre pond.

But unlike some others in the field who simply lagoon the wastes, Frontier burns any that are combustible—employing a gun-type burner that is said to reduce the waste to smokefree gases. The company treats the noncombustibles before discharging them into the pond.

▶ **By Tanker or Drum**—Wastes arrive by tank truck or in drums from the company's major customers, which include steel mills and a truck manufacturer. If the wastes are not combustible, they are transferred to mixing tanks where, following evaluation by chemical analysis, they are neutralized or given other treatments.

Frontier's present throughput rate is 25,000 gal./day. While its charges have not been divulged, they are based on characteristics of the waste to be treated.

▶ **Should Please CPI**—Faced with stiffer pollution laws (*Chem Eng.*, Jan. 23, p. 78) the chemical processing industry has several possible outs.

Some municipalities are operating facilities for treatment of industrial wastes, charging special fees. But often the industrial load is too great, forcing companies to help build treating plants or construct their own in-plant facilities (*Chem. Eng.*, Jan. 23, p. 79).

Frontier, by receiving many different types of wastes, should be able to use some of them to treat others. For example, it could use alkaline wastes to treat acids. Also, firm's higher volume and specialization should give increased efficiency and lower costs.

New Pulp-From-Bagasse Project Gets Under Way

Details have just been released concerning the United Arab Republic's plan for producing paper pulp from bagasse—the stalk residue from sugar refining. Parsons & Whittemore, New York, which made the engineering studies for the plant, has been selected as the contractor, in addition has secured a one-year management contract. And the U. S. Development Loan Fund has already signed a $6.7-million loan for the project.

The pulp plant will be erected at Edfu, Upper Egypt, near sugar mills that are now under construction. It will have an initial output of 18,000 metric tons/yr., is expected to save the U.A.R. $2.7 million in foreign exchange each year. Demand for pulp in the country is estimated at 160,000 tons by 1965.

This Egyptian project underscores upsurging worldwide interest in bagasse as a source of pulp. Crown-Zellerbach has developed a process for utilizing the sugar waste that has been licensed to Sahu Jain, Calcutta, India, for use in a 60,000-ton/yr. newsprint plant near Bombay (*Chem. Eng.*, Nov. 14, 1960, p. 103). Key to the process: blending mechanically and chemically refined pulp.

Mechanically refined bagasse is produced in disk refiners that yield a fine powder—only 12% is retained on a 100-mesh screen. Powder leaving the refiner is bleached with any of the conventional bleaches (e.g., chlorine) then mixes with the fibrous chemical pulp to form the final product.

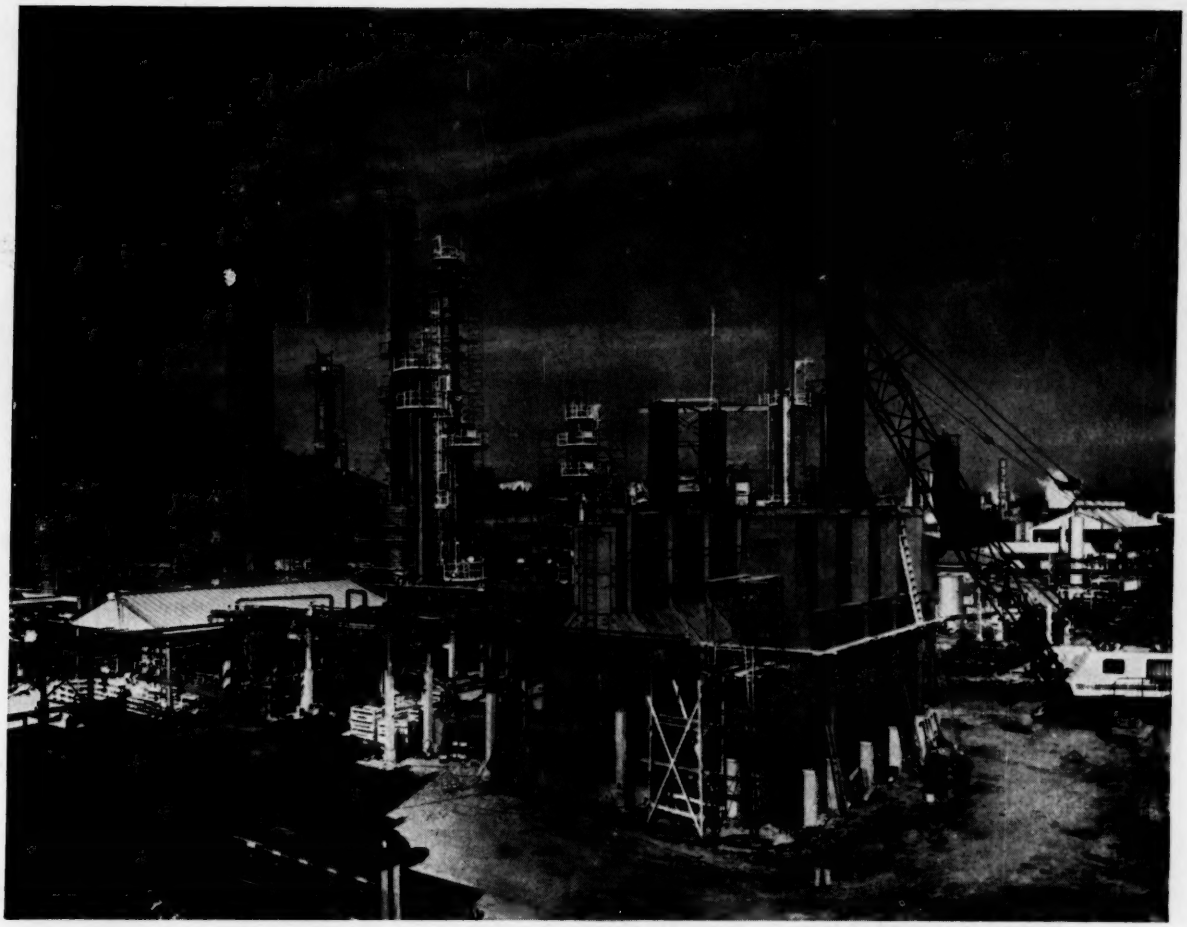
Plastic Industry Founds Institute for Research

Now in the late formative stages is an institute to serve the research and educational needs of the plastics industry. Called the Plastics Institute of America, it will conduct fundamental research on polymer applications. Further, it will be concerned with the education—at graduate-school level—of a large number of qualified plastics engineers and chemists, badly needed by the industry. It plans to affiliate with one of the country's leading educational institutions.

Assured of industry-wide support by replies received from a series of questionnaires distributed during the past few months, the organizing committee is proceeding with formal incorporation of the institute as a nonprofit organization.

Financial support will come from dues paid by a membership consisting of manufacturing firms, nonprofit organizations, consulting firms, government agencies, etc. The Society of Plastics Engineers has underwritten the institute's formative stage.

Chairman of the Plastics Institute Committee is J. W. Lindau, president, Southern Plastics Co., Columbia, S. C.



Ashland Oil completes world's first petroleum naphthalene unit!

Start-up operations are now under way on the world's first unit to produce naphthalene from petroleum in commercial quantities. A development of Ashland Oil research, this patented, hydrodealkylation unit, valued at several million dollars, was constructed in the record time of seven months at Ashland Oil's principal refinery near Ashland, Kentucky.

It is anticipated that the output of this revolutionary new unit, which has an announced capacity of 75 million pounds of naphthalene of the highest purity available, will virtually eliminate the shortage of naphthalene that exists today in the domestic market. In addition, this new unit will contribute measurably to alleviating the world-wide shortage of high purity naphthalene.

You can look to Ashland Oil as a reliable source of supply for high purity naphthalene and benzene as well as such chemicals as toluene, xylene and heavy aromatic concentrates. Under active appraisal and consideration are the manufacture of other petrochemical "building blocks" used in the fiber, plastics, rubber and coating industries.

We welcome your inquiries on all products and potential uses, and will be most pleased to work with you in making the necessary studies and economic evaluations for your particular requirements. Call or address your inquiries to National Account Department, Ashland, Kentucky.

Ashland OIL PRODUCTS

ASHLAND OIL & REFINING COMPANY

ASHLAND, KENTUCKY

CPI News Briefs

- Processes
- Plants
- Offices
- Companies
- International

Processes

License for design and fabrication of plants to use the Stretford process (*Chem. Eng.*, Dec. 26, 1960, pp. 44-46) has been granted to W. C. Holmes & Co., Ltd., Turnbridge, Eng. The Stretford H_2S absorption cycle can be used to clean up synthesis gas and petrochemical feedstocks where low sulfur content is required. Process can also be used to increase sulfur yields from Claus converters and to remove dissolved H_2S from petroleum distillates by liquid-liquid extraction.

An electric arc heater, with possible application in production of acetylene and other petrochemicals, has been developed by Westinghouse Electric Corp. The device can supply a stream of gas at temperatures as high as 20,000 F. and pressures up to 15,000 psi. A prototype model has operated at a power input of 1,700 kw., and power rates as high as 30,000 kw. are planned. The machine might also be used to make a number of refractory metals available in ingot form for the first time.

Plants

Dow Chemical Co. has announced that it will build a second polyolefins plant at Plaquemine, La. Facility will cost $6 million, will be designed to make polyethylene, polypropylene, and copolymers of ethylene and undisclosed compounds. Firm will use its own process, describes it as an improved version of the Ziegler route to linear polyethylene. Site preparation is expected to start by May, with construction scheduled for completion in the second quarter of 1962.

Dow announced in December that its initial polyolefins plant at Plaquemine had gone on stream, producing polyethylene.

Amoco Chemicals Corp. has placed on stream a new plant for producing polybutenes at Wood River, Ill. The facility has increased company-wide capacity for these products by 60%; other Amoco polybutene operations are carried out at refineries in Yorktown, Va., and El Dorado, Ark.

Texaco Inc. reports that construction has started on a 12,000-bbl./day kerosene hydrotreater at the firm's refinery at Port Arthur, Tex. Design, engineering, purchasing and construction are being handled by Fluor Corp., Ltd., Los Angeles, and the unit is scheduled for completion the middle of this year.

Bunker Hill Co. tentatively plans to build a $5-million sintering facility and sulfuric acid plant at the firm's lead smelter at Kellogg, Idaho. Design and engineering studies for the project are due to be completed this year; the company will make a final decision on going ahead with the proposal when design work is finished. Proposed unit would add 75,000 tons/yr. to BH.'s sulfuric acid production.

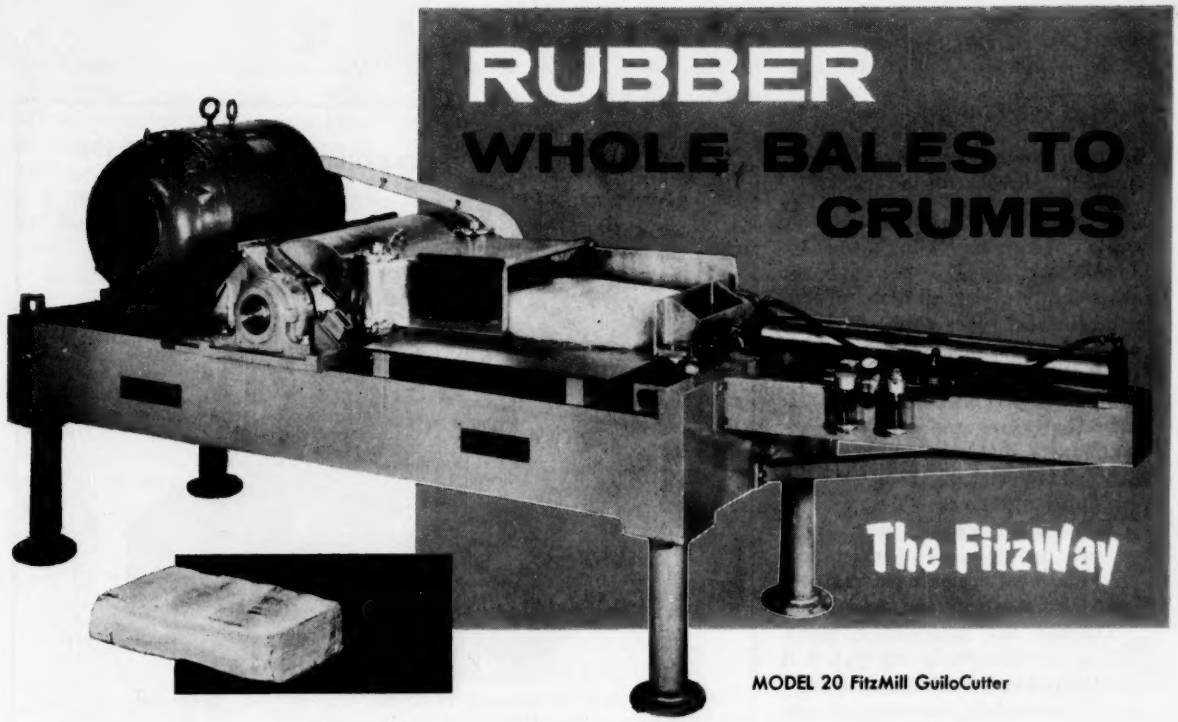
Oxo Chemicals Co., Chicago, a firm owned jointly by Pittsburgh Chemical Co., Pittsburgh, and Amoco Chemicals Corp., will build a multimillion-lb./yr. plant to produce isooctyl and decyl alcohols at Haverhill, Ohio. Construction is scheduled to start this spring.

Humble Oil & Refining Co.'s petrochemicals-marketing organization, Enjay Chemical Co., discloses that ethylene producing capacity at

More CPI News Briefs continued on page 194

Broad Support Attracts New Research Center

Lured by the intense public and academic interest that established North Carolina's nonprofit, 4,500-acre Research Triangle Park, a new subsidiary of The Chemstrand Corp.—Chemstrand Research Center—has established itself there in these buildings. Dedicated early in February, the 500-man facility will conduct basic and exploratory polymer research. Expected migration of other industrial research groups to this park, coupled with the existing concentration of research activity at nearby Duke, North Carolina and North Carolina State Universities, is predicted to make this one of the great research areas of the U. S.



MODEL 20 FitzMill GuiloCutter

. . . at rates up to a bale per minute . . . 60 to 150 HP for different compositions . . . minor temperature rise . . . total elimination of butt ends . . . replaces use of powdered crumbs with attendant savings and elimination of undesirable effects of powder in critical formulations . . . IN . . .

- rubber modified plastics
- salvage recovery in bale production
- adhesives and bonding agents
- sizings and coatings preparation

THE NEW MODEL 20

GUILOCUTTER is designed with *exclusive features to overcome the problems encountered with conventional methods in reducing such resilient products as synthetic rubber bales to a uniform small crumb for further processing needs.

The *exclusive rotor design with staggered bales, path cutters and unique screen produces a uniformly-sized product with no temperature deterioration, and at efficiencies never previously approached.

Product contamination in unpigmented compounds is avoided by the use of stainless steel on all material-contacting parts. Irregular shapes can also be fed with ram guide.

*Patents Pending

All Over the World

THE FITZPATRICK COMPANY

1001 WEST WASHINGTON BLVD. • CHICAGO 7, ILLINOIS • CHesapeake 3-2800

Eastern Division: 714 North Avenue, Garwood, New Jersey
New England Division: 8-16 Warren Terrace, Newton Center, Massachusetts

CLEVELAND • WILMINGTON • SAN ANTONIO • LOS ANGELES • SAN FRANCISCO • TORONTO • MONTREAL • VANCOUVER

Representatives in Foreign Countries

Sealant

Bitumen rubber for low-cost caulking of construction joints.

Reported as the first bitumen rubber for curing in place by simple mixing, UT permanently seals joints under all atmospheric conditions. Unlike rubberized tar or asphalt, which solidify when the solvent evaporates, the new product is a rubber-modified bitumen that elongates easily in expansion or distortion without undue strain on its bond to the adjoining surfaces.

It closely resembles polysulfide rubber in corrosion resistance, cold and heat resistance, weathering, lack of shrinkage, and bond.

Despite the bitumen content, UT is solvent resistant but will swell in solution. Bonding tightly to glass, metals, concrete, wood, UT keeps the bond intact and produces self-sealing characteristics. Its adhesion is related to built-in residual tack; the area exposed to air will lose tack but the inner mass and interface areas retain it. Bond rupture under stress is reduced because of the soft yielding nature of the cured material.

Besides functioning as a caulking compound for curtain wall construction, pipe and culvert joints, concrete basins, floors and storage tanks, UT also encases cable connections and covers the crevices of steel butt joints.

Dip coating, while limited by pot life, produces an effect almost indistinguishable from vinyl plastisol.

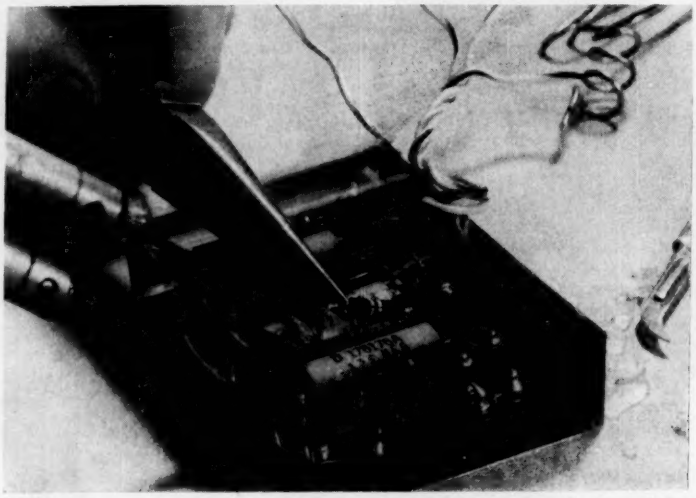
UT working temperature ranges from −40 to 200 F., and the product is pourable as a 100% solid mixture.—**Dittbrenner Associates Inc., Rockaway, N. J.** **104A**

Bactericide

Product packs identical punch of chlorine without side effects.

Described as a combination of fatty acid derivatives, Armazide is a sanitizing agent that kills algae, bacteria and fungi in swimming pools as efficiently as chlor-

Another silicone encapsulant enters market



Defective part is removed from the transparent encapsulant and its replacement soldered into the circuit without damaging the encapsulant.

Additional resin poured over replacement part solidifies without leaving trace of repair.

Just introduced (at the Institute of Radio Engineers convention in New York) Sylgard 182 is the latest encapsulating material that permits visual inspection of circuits and components within potted, embedded or encapsulated assemblies. Applied as a colorless liquid, after blending with its curing agent, the resin cures in place, even in totally confined enclosures, to form a transparent mass of good moisture resistance (0.1% maximum water absorption), flexibility (100% elongation), and toughness (Shore A Scale hardness of about 40).

Sylgard's curing time can be varied by changing the temperature. At 150 C., it cures in 15 min.; at 65 C., 4 hr.; at room temperature, 3 days. While this new silicone exhibits some rubber-like properties, it is not a silicone rubber but a stable resin of tensile strength in the range of 800-1,000 psi.—**Dow Corning Corp., Midland, Mich.** **104C**

ine does. Unlike chlorine however, the new product won't irritate skin or eyes, has no odor, is said to be noncorrosive to pools and equipment.

It cuts in half the amount of chlorine used; usually dosages may be reduced to 0.1 to 0.3 ppm.

Treating water with 2 oz. of Armazide per 10,000 gal. two or three times a week keeps the pool free of algae. The compound doesn't require special feeding equipment but is applied simply by mixing the required amount with several volumes of water and pouring it from a sprinkling can into the pool.—**Armour Pharmaceutical Co., Kankakee, Ill. 104B**

Triphenylphosphorus

Chemical intermediate is readily available for the first time.

Triphenylphosphorus, a white to light-tan crystalline solid (melting point 80-83 C.), previously supplied in laboratory quantities only, is now being produced on commercial scale.

Full availability of this important intermediate will renew interest in the Wittig reaction (conversion of complex aldehydes or ketones to olefins).

Other reactions include: halogenation to the dihalide; oxidation with peroxide to triphenylphosphorus oxide; addition of sulfur to form the sulfide. Reaction with active organic halides gives phosphonium salts.

Triphenylphosphorus reduces quinone to hydroquinone, and disulfides to sulfides. It will add to aliphatic diazo compounds to form azo compounds.—**Metal & Thermit Corp., Rahway, N. J. 105A**

Furfuryl alcohol resins

Switch to amino crosslinkers improves resin.

A new method of crosslinking furfuryl alcohol resins to produce an improved type of coating was detailed in a paper presented at the 1961 conference of the Society of Plastics Engineers, in Washington, D. C.

Erik R. Nielsen of the Armour Research Foundation (Illinois Institute of Technology) told plastics engineers that when polyfunctional amides, amines and amino acids are used as crosslinkers, instead of the usual strong acids they give a more flexible resin with excellent electrical and adhesive properties.

At high temperature, furfuryl alcohol catalyzed by strong acids undergoes intermolecular condensation to build up linear chains consisting of furan nuclei joined by methylene bridges. But in order to obtain a product that is stable on storing, the acid catalysts should be neutralized early in the reaction.

According to Nielsen, considerable quantities of unreacted alcohol must be present during the reaction because if the catalyst acid is not neutralized the resin becomes rubbery, turns black, hard and brittle, and corrosion problems worsen.

▶ **If Shoe Fits, Wear It**—Although use of polyfunctional amines as crosslinking agents violates theory (i.e., that basic compounds inhibit resinification of furfuryl alcohol), these amines give a flexible resin that deteriorates at a much slower rate and adheres well to both steel and copper. Such a resin also possesses excellent electrical properties, can be used with cellulosic materials, and resists attack from acids and alkalis.

Only 2 to 3% of amine crosslinking agent is sufficient to affect the physical properties of the resin. Additional quantities do not produce further crosslinking.—**Armour Research Foundation, Illinois Institute of Technology, Chicago. 105B**

Coatings

New polymers provide better protection for outdoor storage of bulky materials.

Stockpiles of sulfur, coal, iron ore, chrome ore, fly ash and many other bulk materials usually stored outdoors create dust and pollute the atmosphere.

Recently, a new blend of organic, long-chain polymers in a water base has been developed to protect these outdoor piles from wind losses and rain erosion. Called SP-301, the compound forms a thin but tough crust that is reported highly resistant to weather.

This crust, formed by spraying the compound, reduces the large tonnage losses suffered each year.

Inert and nontoxic, SP-301 has no adverse effects on the burning quality of coal or on subsequent processing of sulfur and metal ores. Its protective action is said to last for more than a year, and

Newsworthy Chemicals

Page number is also reader service code number

Bitumen rubber for low-cost caulking of construction joints.....104A
New bactericide for swimming pools won't irritate eyes or skin....104B
Silicone encapsulant resin features ease of application.....104C
Triphenylphosphorous goes commercial.....105A
Amino crosslinkers improve furfuryl alcohol resins.....105B
Polymeric coatings protect ore stockpiles from weather.....105C
Teflon tape won't crack or split at high temperatures.....106A
Polypropylene's tensile strength increases on flexing.....106B
Silver-brazing flux operates between 600 and 1,800 F.....106C
Enzyme-hydrolized soy protein is source of amino acids.....106D
Polyethylene coating on pipes withstands bending, flexing.....106E
Propylene oxide adducts go into biocides, defoaming agents.....106F
Modified polybutadiene boasts abrasion resistance.....106G
Water glycol fluid provides fire protection in hydraulic systems....106H

For more details use Reader Service Card

1 gal. can be sprayed easily over 100 sq. ft. of surface.—**The Johnson-March Corp., Philadelphia, Pa.** 105C

Teflon tape

New tape withstands high temperature without cracking or splitting.

Low-shrinkage Teflon (TFE resin) tape can successfully reduce the reject rate of small-diameter braid-jacketed cable by as much as 90%.

The new Teflon product is a regular skived tape with controlled low shrinkage; it won't show more than 2% change in any dimension when heated at 730 F. for 15 min. This is especially important to wire manufacturers requiring insulators capable of withstanding prolonged exposure to high temperature without the cracking or splitting common to tapes with large or variable shrinkage characteristics.

Product is available in thicknesses from 1 mil. up and widths from ¼ to 12 in. Tensile strength, at 0.003 in. thickness, is 4,000 psi. minimum, and elongation 300% minimum. Dielectric strength is 2,700 v./mil minimum.—**Dixon Corp., Bristol, R. I.** 106A

Polypropylene

New property of the plastic is discovered.

Molded hinges made of polypropylene have been subjected to tests involving 1,000,000 flexes without evidence of failure.

Experts attending the 1961 conference of the Society of Plastics Engineers, in Washington, were even more baffled when they learned from R. D. Hanna of Hercules Powder that repeated flexing of polypropylene hinges "actually increases the tensile strength of the plastic; [but] . . . precise reasons for this have not been determined."

Capitalizing on this unusual property, some manufacturers have already started to make a wide variety of new containers, such as cases for eyeglasses or phonograph records, with molded-in hinges (lid and main section of the containers comprise a single plastic unit). Although the hinge is often membrane-thin, it possesses unlimited flex life.

Propylene accelerator pedals are being evaluated by all major automobile manufacturers, and preliminary studies reveal better wear and abrasion resistance, indicate a reduction of 50 to 70% in initial cost and additional economies in accessory parts and assembly time.

Air-deflection registers for car air-conditioners have already been redesigned to make use of the polypropylene integrally molded hinge. The switchover, according to Hanna, trimmed production costs by 66%, cut assembly time by 68%, and reduced the weight of the unit by 92.5%.—**Hercules Powder Co., Wilmington, Del.** 106B

Briefs

Silver-brazing flux, S-200 Brazaloy, for torch, furnace or induction brazing, has an active range between 600 and 1,800 F. Used when tight joints need superior capillary flow, this flux is reported to give a faultless brazing film during the heating cycle.—**All-State Welding Alloys Co., White Plains, N. Y.** 106C

Enzyme-hydrolyzed soy protein, HSP 85, is a water-soluble powder useful as a fermentation nutrient and chemical intermediate. Containing 8.5% total nitrogen, of which at least 20% is in the amino form, this soy protein is an economical source of soy peptones, peptides and amino acids.—**Amber Laboratories, Milwaukee.** 106D

High-density polyethylene coating, X-Tru-Coat, consists of an extruded plastic jacket bonded to steel pipes, with a specially developed adhesive that remains alive for bending and flexing during installation. Full production of this corrosion-resistant coating will begin in a few months.—**Hill Hubbell Co., Cleveland.** 106E

Propylene oxide adducts, Propomeen C/12, C/25, HT/12, HT/25 are organic bases that contain a minimum of 95% tertiary amines. Quaternary ammonium salts formed by neutralization of Propomeens with inorganic acids or low-molecular-weight organic acids display surface active properties and are soluble in water and alcohols. They can be used as chemical intermediates, biocides, defoaming agents, demulsifiers.—**Armour Hess Chemicals Ltd., London, England.** 106F

Modified polybutadiene polymer, Hycar 1000X145, won't become brittle even at temperatures as low as −85 F. Moderately resistant to fuels, solvents and chemicals, Hycar is said to have the abrasion resistance and good electrical properties necessary in wire and cable insulation. Other applications: machine parts, hose coverings, coating for fabrics, shoe soles and heel lifts where abrasion resistance is important.—**B. F. Goodrich Chemical Co., Cleveland.** 106G

Water-glycol fluid, Cellugard, provides fire protection for industrial and military hydraulic systems. Product is reported suitable for use in low-pressure hydraulic systems that do not require the heavy-duty properties of straight phosphate ester fluids. Noncorrosive and compatible with standard packing materials, Cellugard costs less than phosphate esters, contains special additives that protect against vapor and liquid phase corrosion.—**Celanese Corp., New York.** 106H

For More Information about any item in this department, circle its code number on the Reader Service Postcard (Page 227)

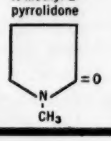
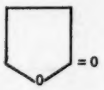
two practical solutions to solvent problems

METHYLPYRROLIDONE and BUTYROLACTONE

These two heterocyclic solvents are a source of new ideas and techniques in production areas which concern the polymer chemist, the coating formulator, the processor interested in such diverse fields as wire insulation enamels, acetylene recovery, degreasing, pigment dispersion, resin removal, germicides and insecticides.

Combining optimum solvency with maximum safety in industrial handling, this stable lactam and this versatile lactone each offer many special features:

- high solvent capacity
- good hydrolytic and thermal stability
- wide organic-solvent and water miscibility
- high boiling and low freezing points
- noncorrosiveness
- ease of recovery
- low vapor hazard

	N-Methyl-2-pyrrolidone	Butyrolactone
Structure		
bp (°C)	202	204
mp (°C)	−24	−44
flash p (°F)	204	209
sp gr 25/4°C	1.03	1.12
viscosity cp at 25°C	1.7	1.7
completely miscible with	water, most organic solvents	water, methanol, acetone, benzene, carbon tetrachloride, ethyl ether, monochlorobenzene (immiscible with aliphatic hydrocarbons)

POLYMERS — **Solvents** of unusual utility, Methylpyrrolidone and Butyrolactone can be effectively used for a wide range of resins, including PVA, PVC, polystyrene, nylon and aromatic polyamides, polyesters, polyacrylics, cellulose derivatives, and fluorinated hydrocarbons.

In surface coatings, these solvents improve the fluxing and fusing of resins into uniform and continuous films by controlling the rheological properties of the formulation, e.g., methylpyrrolidone speeds coating action of many resins in wire insulation enamels. In **purification** of compounds with limited solubility in other organic media, good yields and high purity can be obtained from these solvents, e.g., recrystallization of terephthalic acid from Methylpyrrolidone and purification of polyamides with Methylpyrrolidone or Butyrolactone. In **paint removers,** in the **stripping of plastisols** or other resinous material from valuable substrates, and in the **solvent welding of plastic films,** Methylpyrrolidone and Butyrolactone act as highly effective softening agents. Methylpyrrolidone is also useful as a **spinning solvent** for synthetic fibers.

AGRICULTURAL CHEMICALS — Methylpyrrolidone is an effective and efficient solvent for mercurial seed disinfectants as well as common insecticides, such as chlordane, DDT, lindane, and toxaphene.

PIGMENTS — Methylpyrrolidone, as a dispersing and wetting agent, facilitates incorporation of organic and inorganic pigments into coating systems. Its dispersing action tends to increase tinctorial strength and reduce color drift. Thus, Methylpyrrolidone provides a means of extending expensive pigments and aids in the economical preparation of a universal tint.

DEGREASING — Butyrolactone improves the efficiency of anionic and nonionic surfactant systems in industrial cleaning and degreasing operations.

HYDROCARBON REFINING — In the Sacchse-Wulff process, Methylpyrrolidone has many advantages as a selective solvent for acetylene gas (39 volumes to 1). This lactam combines chemical and thermal stability with low toxicity and ease of recovery.

Butyrolactone is a new extractant for C_4 hydrocarbons in petroleum processing.

CHEMICAL SYNTHESES — Chemically inert, Methylpyrrolidone is a **reaction solvent** which encourages high yields and reaction rates and discourages the formation of by-product, e.g., in the Rosenmund-von Braun synthesis of aromatic nitriles, catalytic ethynylation of ketones, vinylation of nitrogen compounds, organic alkaline reactions, and alkylation of enols. Butyrolactone is a **chemical intermediate** for herbicides, pharmaceuticals, rocket fuels, and plasticizers.

Mail the coupon today to reserve a copy of the revised, up-to-date technical review on Methylpyrrolidone (now in press), and to receive additional information on Butyrolactone.

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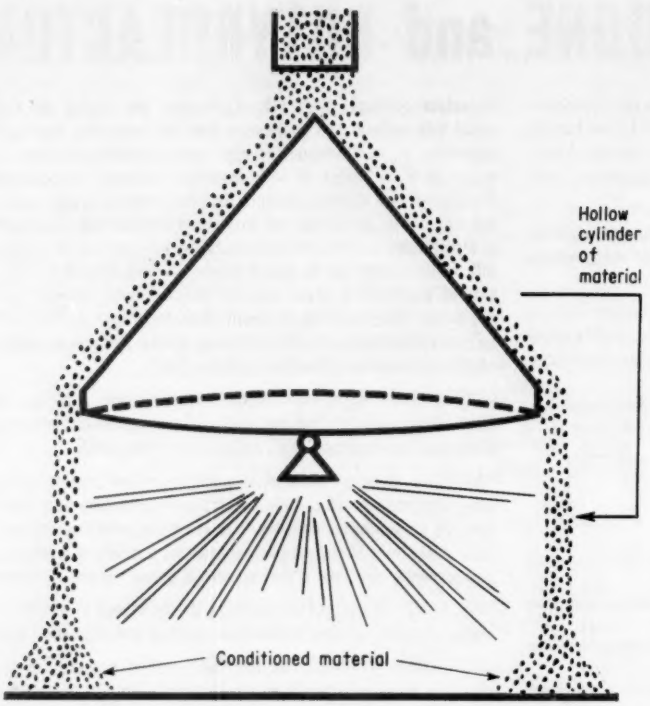


CONTINUOUS UNIT SPRAYS LIQUID UNIFORMLY ON FLOWING SOLIDS

Internal cone thins down solids stream so jet spray can reach every particle, for complete wetting action.

Adding moisture to dry particles—not considered one of the 17 classical unit operations—can sometimes be a difficult and exasperating procedure. If the final product must be evenly coated and free-flowing, the difficulties are magnified.

A new device, called Verticone, uses a very simple principle to add liquids to solids automatically and continuously, without degrading the particles.

▶ **Forms a Thin Curtain**—Feed material is directed over a cone so that falling solids form a continuous curtain in the form of a hollow cylinder. An internal spray nozzle jets wetting liquid in a 360-deg. arc, putting a coating on the falling material. By adjusting feed and spray rates, a wide range of moisture can be applied to the solids.

Application of the device to conditioning of materials is almost limitless. Some of the more important uses include:

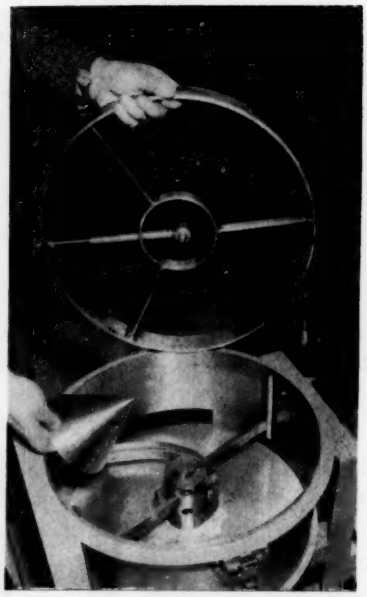
- Introducing a specified moisture content.
- Coating granules or flakes with dyes or coloring material.
- Prewetting or preconditioning prior to processing.
- Making suspensions.
- Rendering dry materials dust-free.

Big advantage of the unit over batch mixing or other spray processes is that by first reducing the solid material to a relatively thin layer, local over- and under-wetting is largely eliminated. In dust-control applications, the wetting treatment can be entirely negated if the process forms wet-on-the-outside, dry-on-the-inside balls that break up from subsequent handling, releasing dust at unexpected places in the process.

▶ **Continuous and Uniform**—By handling a stream rather than batches of bulk material, the Verticone saves considerable time required for loading or unloading batch units. It also saves space, since the ½-hp. unit, 32 × 20 × 30 in., processes 3,500 lb./hr. of 50 lb./cu. ft. material. Larger machines handle up to 88 tons/hr. of the same material.

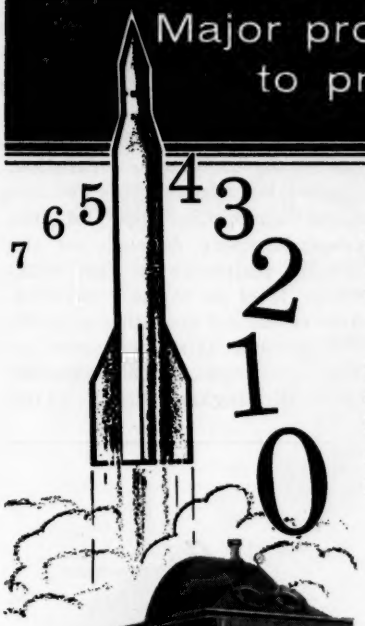
Verticone is automatic once solid and liquid flows are set. Any suitable feeder that controls rate within ± 5% of a given rate can be used to control feed, while proportioning and dispensing equipment are available for mixing (if necessary) and applying liquid.

▶ **Simple Operation**—Solid material is fed into a pipe that is centered directly over an inverted cone. As the material splits on the cone's point, it flows down and off the edge, forming a cylinder-shaped curtain between ¼ and ¾ in. thick. Simultaneously, a nozzle under the cone, inside the



Verticone comes apart easily for cleaning, can be used for food as well as chemical, drug applications.

Major producers count on **DAY** equipment to process solid propellant fuels



DAY builds equipment specifically designed to meet the exacting requirements for processing solid propellant fuels. The machine types shown here have been specified by major producers of solid fuels for their safe and efficient operation, ruggedness and thorough dependability.

Investigate the many proven advantages of DAY equipment for your processing work. You'll receive every benefit that more than 70 years of experience in building a variety of processing machinery can bring, plus DAY'S matchless reputation for reliability and service. Write for detailed information on DAY equipment to meet your requirements, or call in a J. H. Day Company field engineer.

The J. H. DAY Co.

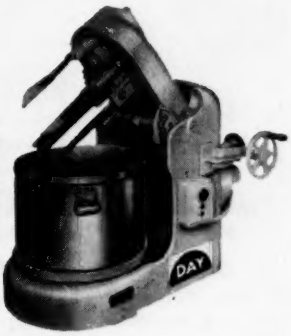
Division of The Cleveland Automatic Machine Co.

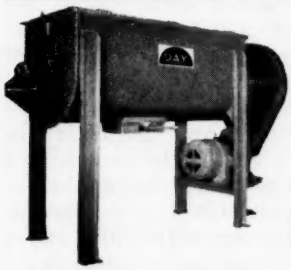
4928 Beech Street, Cincinnati 12, Ohio

MANUFACTURERS OF QUALITY MIXING, BLENDING, SIFTING, MILLING EQUIPMENT SINCE 1887

DAY DISPERSION MIXERS offer many special features for processing solid propellants: Jacketed stainless steel tank; close temperature control; many safety features; provision for vacuum mixing; equipped for remote operation. Available in a complete range of laboratory and production sizes, ¼—300 gal. capacities, ¾ to 150 h.p. drives. Write for Bulletin 1157.

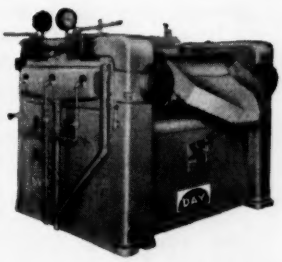
DAY PONY MIXERS twin or single motion, provide fast, thorough mixing of curing agents and high performance fuel additives Whatever your requirements, there's a DAY Pony Mixer specifically designed to do the job. Write for Bulletin 500.





DAY RIBBON BLENDERS provide fast, pre-blending of oxidizer grain sizes prior to final dispersion mixing of the composite fuel. Built in a wide range of rugged tank sizes and designs, with various types of agitators. Write for Bulletin 800.

DAY 3-ROLL MILLS produce fine dispersions of fuel curing agents that were previously blended in DAY Pony Mixers. DAY Mills are built in 10" x 22" and 14" x 30" sizes for production quantities; in 5" x 12" and 4" x 8" sizes for pilot operations. Write for Bulletin 158.

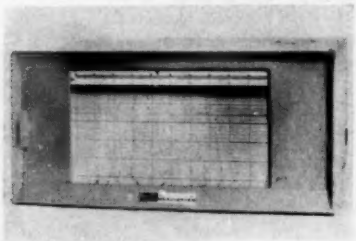


DAY RO-BALL GYRATING SCREENS use super-active ball cleaning principle to sift foreign materials from oxidizers and additives; to obtain selected grain sizes for burning rate control. Many models are available to provide from two to five separations, with choice of discharge designs. Write for Bulletin 957.

cylinder, sprays a liquid that reaches all the particles, coats their surfaces.

The treated material may drop directly onto a chute or conveyor —or into other equipment—or it may be discharged by a rotary table feeder. A scraper continuously removes any treated material clinging to the walls inside the conditioning area.

Because of its application in food processing, the stainless steel Verticone is constructed to meet sanitary codes. The entire unit may be taken apart for cleaning in a minimum of time.—**Johnson-March Corp., Philadelphia. 108A**



Recorder

Multipoint strip-chart device measures 2 to 12 input sources.

Only 8½ in. high and 19 in. wide, this compact multipoint strip-chart recorder scans up to 12 inputs at the rate of 5 sec./point. Faster or slower print rates are available on request. Plug-in range modules permit rapid changes between temperature and millivolt spans. Printout charts are 11 in. wide. Separate ink pads print six different colors.

Available but optional: adjustable alarm switches, "print-no-print" point selection, detachable ball point pen for continuous single-point records.—**Westronics Inc., Fort Worth, Tex. 110A**

Gas chromatograph

High-speed, high-resolution unit is designed for the laboratory.

This self-contained chromatography instrument employs flame ionization for detection. Supplied complete with semimicro packed columns, it guarantees high speed, high sensitivity and high resolution for most laboratory analyses, particularly of hydrocarbons.

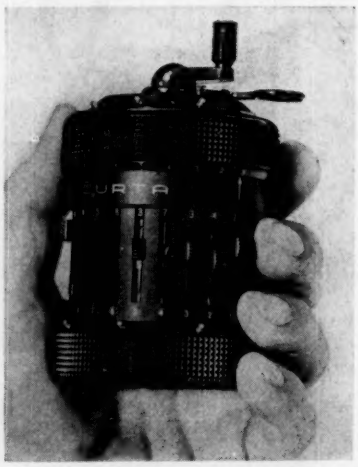
Unit includes an electrometer amplifier and a 30-150 C. thermostatically controlled oven, both housed in a vinyl-clad aluminum cabinet. Either hydrogen or inert-gas carriers are effective, due to a specially designed burner tip with concentric nozzles. A miniature spark coil ignites the flame.

Electrometer circuitry provides full-scale sensitivities of 3×10^{-11} amp. with a 10-mv. recorder. (With well-stabilized hydrogen and carrier-gas flows, this can be increased to 3×10^{-12} amp., by a 1-mv. recorder.) A stylus system with a pen speed of not less than 1 sec. is required. Seventeen ranges with a total attenuation of 200,000:1 are built in.—**Hallikainen Instruments, Berkeley, Calif. 110B**

Liquid-level control

Low-sensitivity electronic unit is floatless, won't contaminate.

Designed for liquids of low specific resistance, this floatless level control is described as "fail-safe" and "particularly suitable" for chemical processing since it doesn't contaminate, won't spark. Unit's low electrode potential (9 v.) and current (25 milliamp.) are designed for low sensitivity. Other features: terminal wiring for direct or inverse operation, fixed resistor mounted on the terminal strip. Selection of the proper resistor depends on the specific resistance of the liquid whose level is to be controlled. Remote control operation is possible through telephone lines or other lead wires.—**B/W Controller Corp., Birmingham, Mich. 110C**



Portable calculator

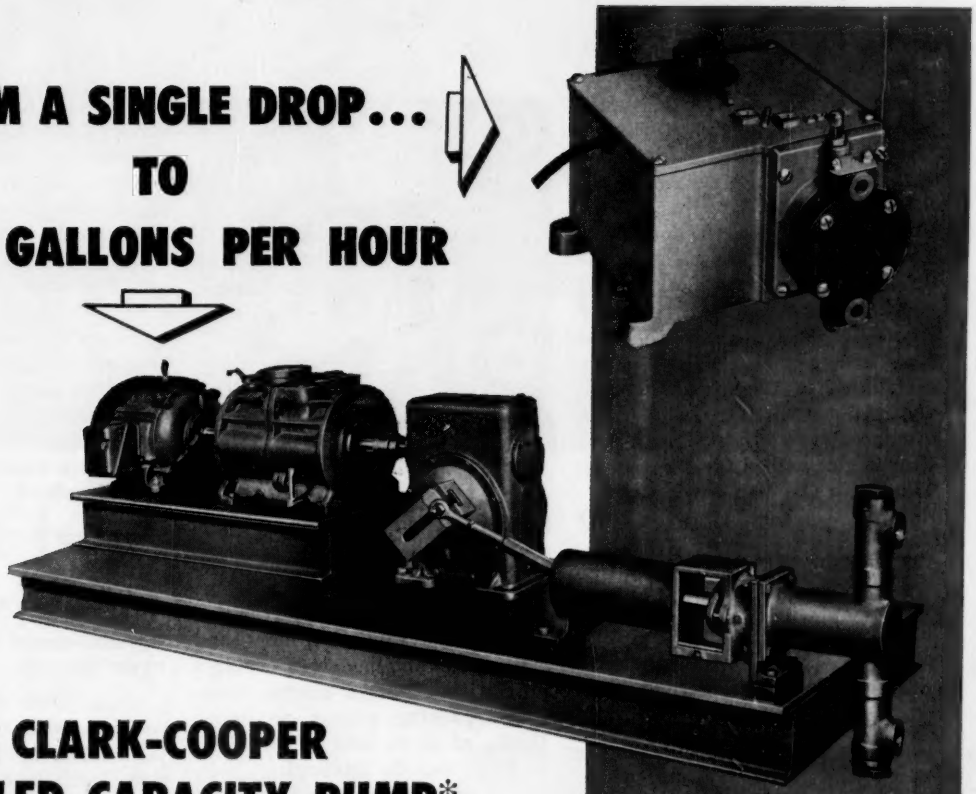
Slide rule convenience combines with desk calculator accuracy.

Compact, lightweight calculator is said to combine the accuracy, speed and versatility of a large desk calculator with the portability of a pocket slide rule. Precision-made of stainless steel and anodized aluminum alloys, the cylindrically shaped device is hand size: 2 1/16 in. dia., 3 3/8 in. high. It weighs 12 oz.

Dubbed "Curta," the calculator has 11 digits on the keyboards, 8 on the indicator dial and 15 in the answer dial. This corresponds to an answer on the order of 100 trillion.

Noiseless, rust- and corrosion-proof, Curta does not require an external power supply. Main barrel assembly contains color-coded keyboard knobs and movable white decimal markers. Once

FROM A SINGLE DROP... TO 3400 GALLONS PER HOUR



There's a CLARK-COOPER CONTROLLED CAPACITY PUMP* for continuous, accurate metering of all types of liquids

CLARK-COOPER CONTROLLED CAPACITY PUMPS are precision-built to accurately measure and transfer liquids, slurries and suspensions at a specific, adjustable rate of flow, regardless of pressure variations in the system.

FROM BASIC SIMPLEX MODELS with a capacity of one drop every 13 strokes at pressures of 10,000 P.S.I., to quadruplex models with capacities of 3400 GPH, there's a Clark-Cooper CC pump for your specific application . . . with job proven volumetric metering at repeatable accuracies of ±½%.

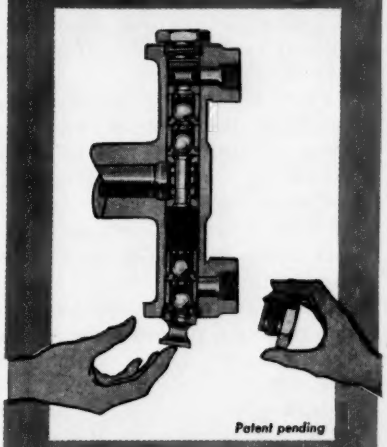
FUNCTIONALLY INTERCHANGEABLE Clark-Cooper pumps are manufactured in both diaphragm and plunger type construction. Conversion from one to the other can be accomplished quickly and economically in the field.

THOUSANDS OF C/C METERING PUMPS now in operation have proven their abilities under the most severe operating conditions in the chemical processing, petro-chemical, water and waste treatment and paper and pulp industries.

Write today for detailed information on the proven Clark-Cooper CC Pump line . . . the only *complete* line in precision liquid metering.

*(*either plunger or diaphragm type*)

THE EXCLUSIVE CLARK-COOPER LIQUID-END DESIGN



Exclusive drop-out check valve construction of Clark-Cooper pumps provides easy disassembly for inspection and maintenance.

Valve units are stacked in the straight column liquid end and are easily accessible when threaded end plugs are removed. Units are self-aligning and interchangeable for fast, simple reassembly.

CLARK-COOPER DIVISION
FREDERIC B. STEVENS, INC.
Palmyra, (Burlington County) New Jersey
Representatives in All Principal Cities

a number is keyed, it holds until calculation is complete. A driving cog-axle passes through the center of Curta, is actuated by a short-radius operating handle designed for high-speed operation. Knurled carriage contains revolution counter, result dial, and additional decimal markers. A single lever will clear the two dials, either simultaneously or individually. Automatic stops prevent both errors and damage from overspeeding in hasty operation. Unit is guaranteed for one year.—**The Curta Co., Van Nuys, Calif.** 110D

High-pressure equipment

Pump, compressor take 100,000 and 20,000 psi., respectively.

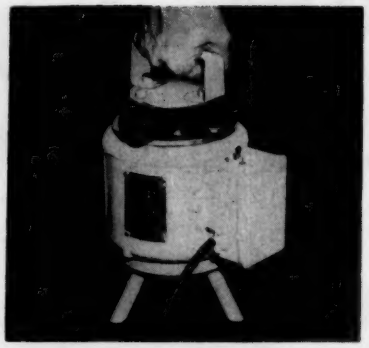
For laboratory or production, compact chemical-proportioning pump and two-stage diaphragm gas compresor withstand ultra-high pressures—100,000 and 20,000 psi. respectively. Self-contained, base-mounted, ready for connection to power source, units are said to operate under severe corrosive and erosive conditions without evidence of wear on carbide parts.

Pump has a 12 × 42-in. base, height of 21 in. Output capacities cover a range from 1.4 to 203.5 gal./hr.

Compressor is slightly larger: 16 × 46 × 24 in. At 100-psi. input and 100-cycle/min. frequency, it has a rating of 18 scfh.

Both pump and compressor are powered by a reciprocating piston that can be driven with compressed air, gas, steam or hydraulic power, at input pressures of as low as 100 psi.—**McCartney Mfg. Co., Inc., Baxter Springs, Kan.** 112A

For More Information about any item in this department, circle its code number on the Reader Service Postcard (Page 227)

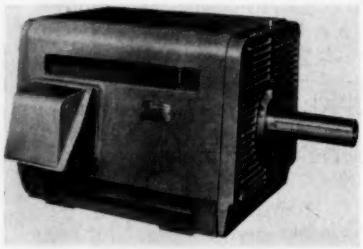


Canned pump

Portable self-primer will handle up to 11 gpm.

Said to be the first of its kind, this portable pump empties drums and tanks filled with corrosives, flammables, toxics. Pump and motor are combined in a compact unit without drive shafts, couplings, packing glands or bases. Heads of 55 ft. and suction lifts of 15 ft. can be attained.

Self-priming and self-lubricating, the unit is said to combine the primary features of positive-displacement-type pumps with the general transfer abilities of centrifugals. Available in cast iron, bronze or stainless steel, it withstands temperatures from 40 to 180 F.—**The Corley Co., Boonton, N. J.** 112B



Smaller motor

Motor size is greatly reduced by putting round peg in square hole.

Placement of a round stator inside a nearly square frame has reduced the over-all size of large a.c. motors. More efficient cooling per horsepower rating allows for the smaller-dimensioned unit.

Available in hp. ratings from 125-300, unit features air intakes at each end. Air is sucked through louvered openings, ducted through the rotor and stator, and exhausted at the sides. Result: better cooling, higher horsepower rating per unit volume.

Either sleeve or ball bearings are available. Drip-proof enclosure is standard; splash-proof, optional. Encapsulated stators can be specified for particularly severe operating conditions. Models are built for 220, 440 or 550 v.; output speeds range from 900-3,600 rpm. —**Reliance Electric & Engineering Co., Cleveland.** 112C

Lubefree speed-reducer

Variable-speed drive machine never requires lubrication.

Even fret corrosion—long a problem with metallic load-bearing surfaces—is eliminated in this variable-speed drive unit, since nonmetallic surfaces carry the load. All bearings, sealed and shielded, are factory-lubricated, require, no further servicing over the machine's life. Shaft surfaces —impregnated with a material described as "exceptionally tough and wear-resistant"—need no lubrication either.

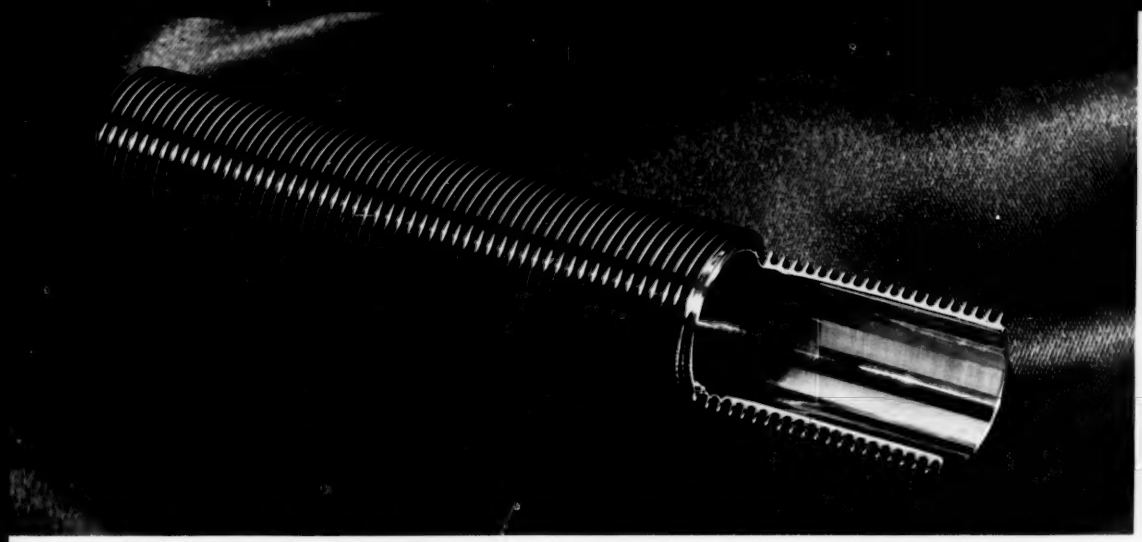
Made in capacities ranging from ¼ to 25 hp., and output speeds from 0.4 to 4,660 rpm. in speed variations up to 10:1, the unit is explosion proof, dripproof, fan-free, yet totally enclosed and lube-free. —**Sterling Electric Motors, Inc., Los Angeles.** 112D

Turbidity controller

Instrument indicates clarity of flowing stream, warns of change

Here's a device that really looks into a process stream to see if conditions in the process are changing. Called a turbidity indicator/controller, it monitors the clarity of effluent leaving a filter, settling pond or flotation opera-

New Equipment continues on page 204



Wolverine Trufin Type S/T

This is Wolverine Trufin® Type S/T

Designed expressly for use in shell and tube heat exchangers, this low-finned tube has an outside to inside surface ratio of approximately 3.75 to 1. The outside diameter of the finned section is equal to the diameter of the plain ends for easy installation and replacement.

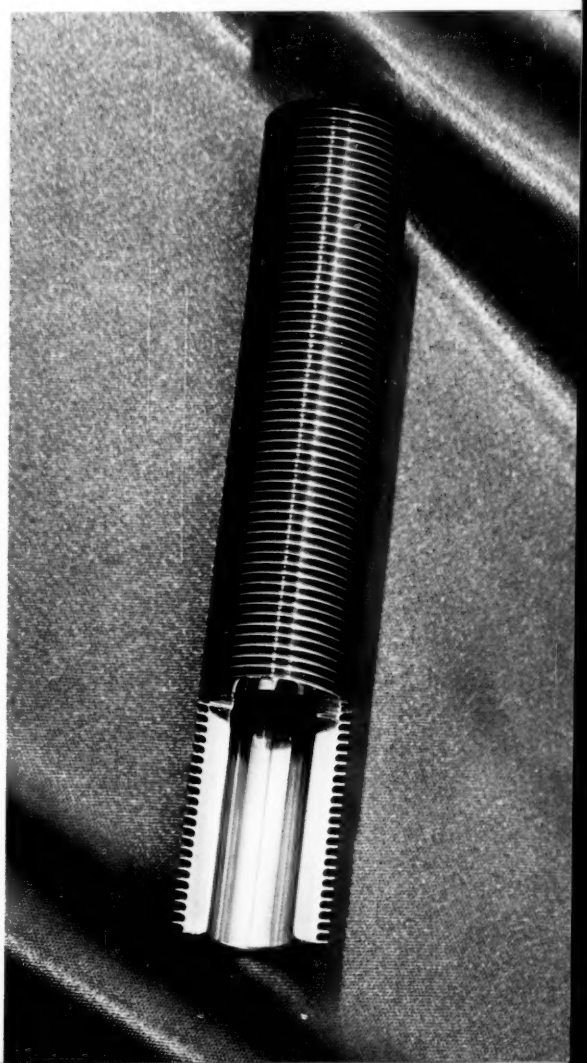
Trufin Type S/T is available in a wide range of alloys and sizes in copper, aluminum and steel and in standard fin spacings of 16 or 19 fins per inch. It can be ordered in straight length or U-bend form. It can also be readily fabricated into coils, bends, etc.

Trufin Type S/T is ideal for tube replacement in shell and tube heat exchangers or in the design of new units. In the former it can increase capacity by as much as 150 per cent. In the latter it permits a more compact unit to carry a heat load equal to a much larger unit utilizing plain tube.

This oustanding low-finned tube is also available as Trufin Type S/T Duplex—an integrally finned outer tube mechanically bonded to a conventional inner tube of any desired metal or alloy. Thus, in one tube, the user has a product with the ability to both increase heat transfer performance and withstand specific corrosive conditions.

Write for more information . . . or Ask Your Wolverine Tube Salesman—HE KNOWS.

Wolverine Trufin Type S/T Duplex



WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. K, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

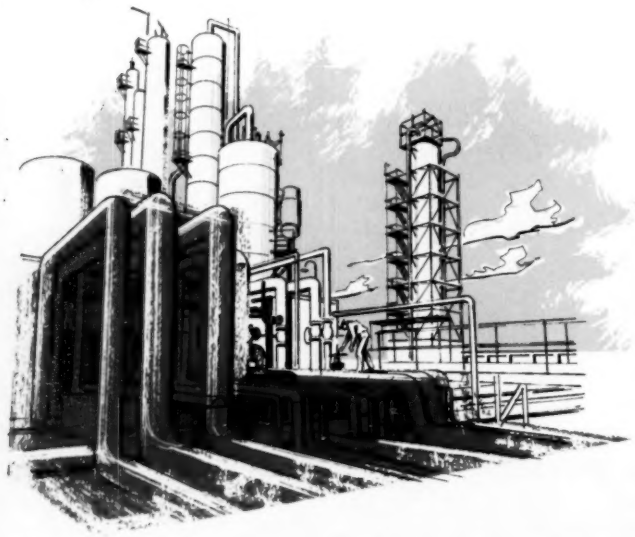
SEE FOR YOURSELF

Take a look at the comparison chart on this page. Selected at random from Wolverine Tube's case history file, it presents dramatic proof of how integrally finned Wolverine Trufin Type S/T increases heat duty—*without increasing unit size.* In this application—the condensing of thermo-cracked straight-run gasoline from a re-run tower—capacity jumped *38%*. Also, when tubed with prime surface tube, the unit was pulled off stream every 90 days for cleaning. After tubing with Trufin Type, S/T, the tube bundle required cleaning only every eight months.

Next time you are considering revamping or retubing heat exchangers or condensers—get the Wolverine Trufin story first—see for yourself how this modern tube can help you do a better job. Write for complete information or Ask Your Wolverine Tube Salesman—He Knows.

THE SITE: A gulf coast refinery
THE WORK: Condensing thermo-cracked straight run gasoline from a re-run tower
THE UNIT: A pressure distillate overhead condenser

	PRIME SURFACE TUBE	TRUFIN—TYPE S/T
No. of tubes	500	500
Outside surface, Sq. Ft.	1522	3280
Metal	16 BWG Admiralty	16 BWG Admiralty
Tube size	¾" O.D.	¾" O.D.
Shell Side, Flow, Lbs./Hr.	19780	27350
—Temperature in	261° F.	261° F.
—Temperature out	125° F.	101° F.
Heat Load, BTU/Hr.	3,960,000	5,820,000



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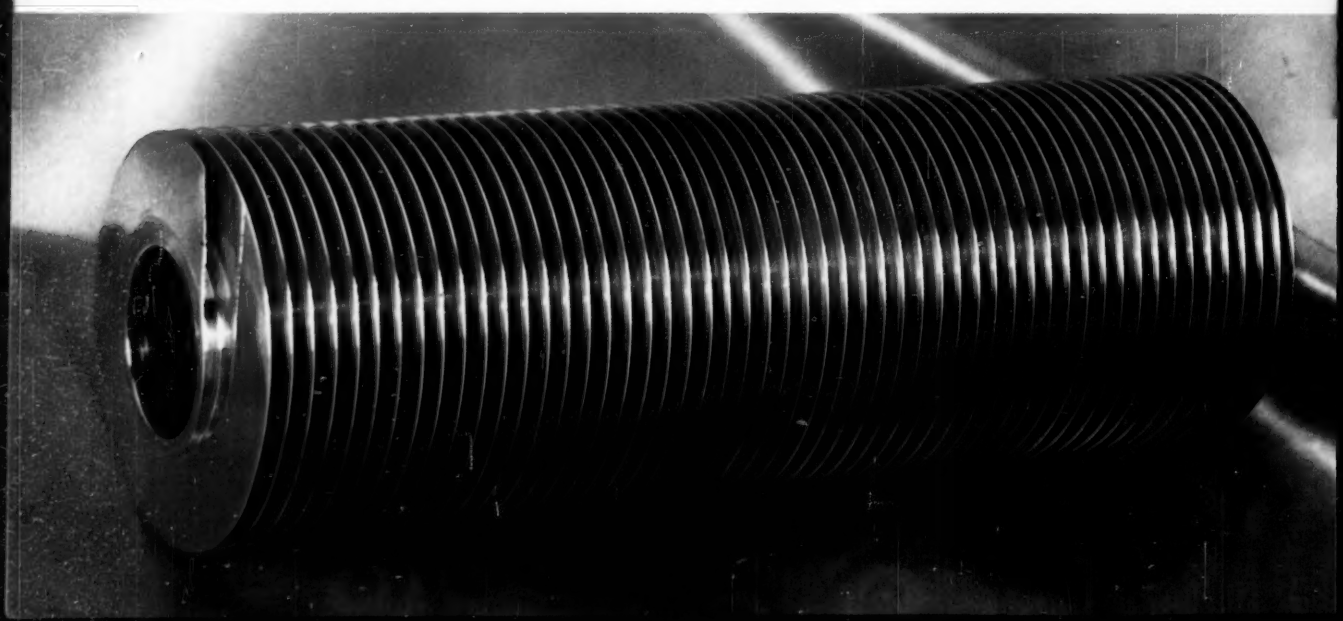
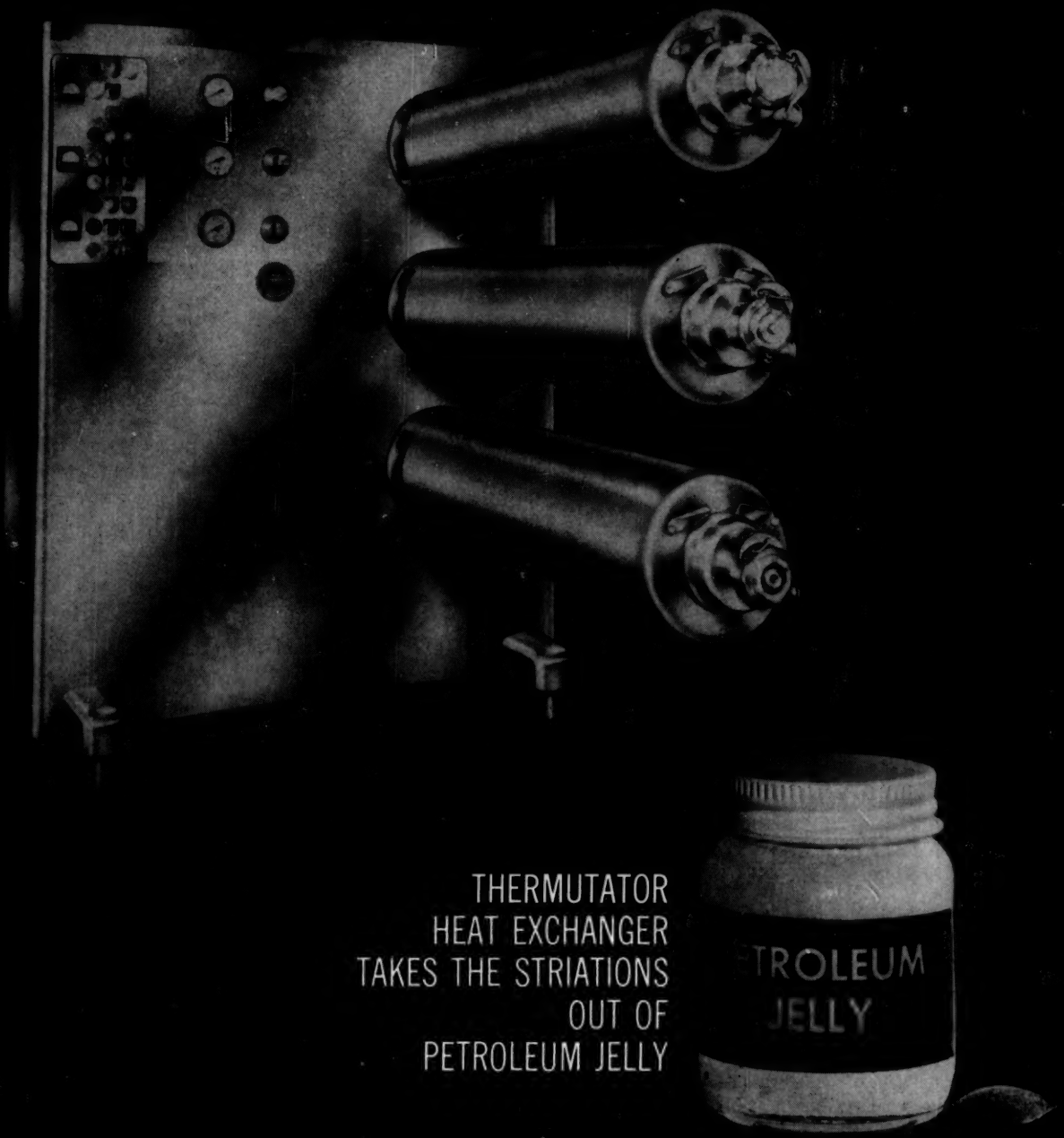
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

WOLVERINE TRUFIN TYPE L/C BIMETAL

And, for those applications where air cooling is advantageous, Wolverine Tube recommends Wolverine Trufin Type L/C. With its high-finned outer tube of aluminum mechanically bonded to a liner of any desired metal or alloy, Type L/C is ideal for use where water shortages or brackish or corrosive waters make liquid cooling impractical. It is finding wide use in refineries, gas plants, pipe line compressor stations, chemical plants, petro chemical plants and transformer oil coolers, etc.





Cherry-Burrell Cures Those Jelly Row Blues

Product appearance can make or muff a sale as a large manufacturer of petroleum jelly discovered. His product lay in unappealing rows or layers of different textured jelly. He asked Cherry-Burrell if they could give his product more of a *togetherness* look, solve his Jelly Row Blues.

After studying his manufacturing process and running laboratory tests on the product, Cherry-Burrell engineers found the trouble. The manufacturer's previous equipment cooled too slowly and produced striations in the jar.

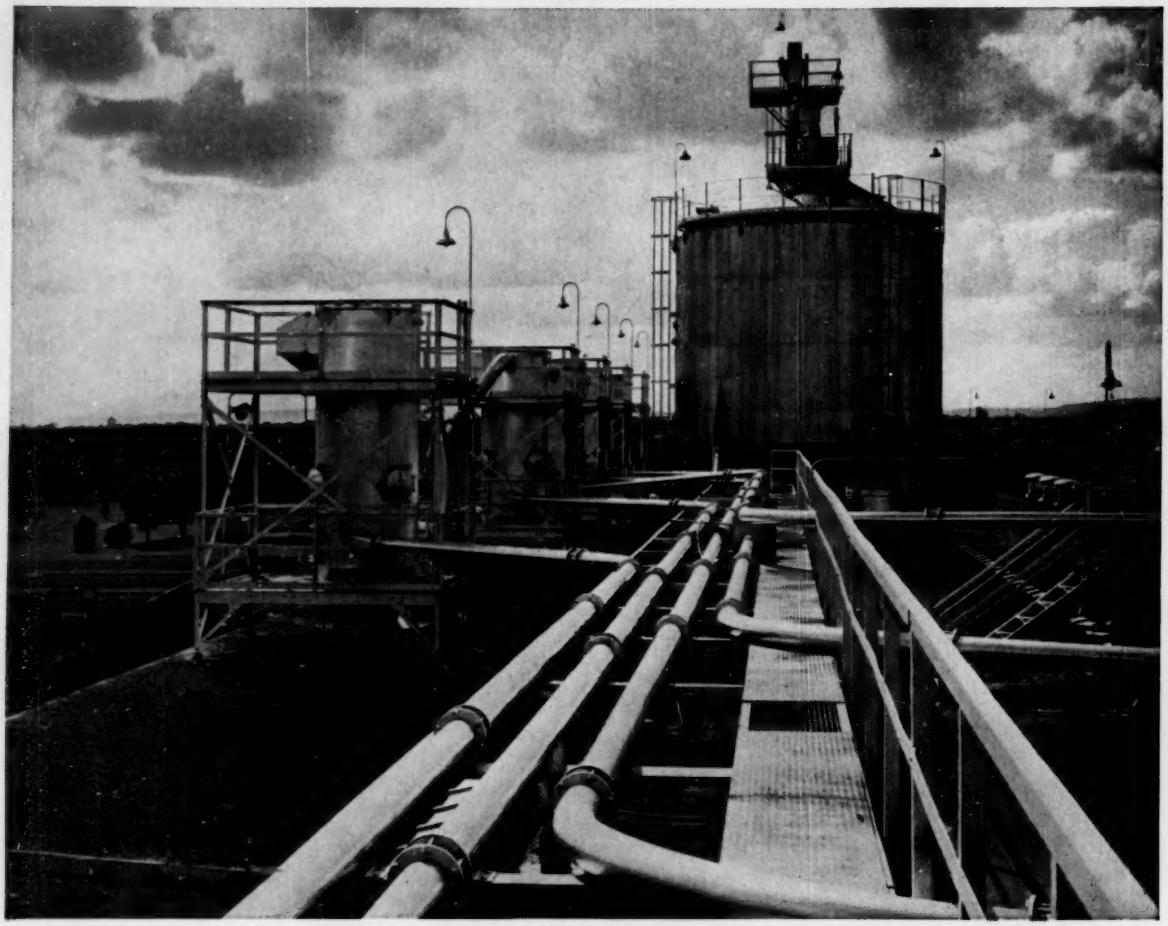
The engineers recommended a Cherry-Burrell Thermutator. Now the manufacturer has complete control over product temperature. And the Thermutator blades texturize the product, give it a smooth, uniform appearance. Sales picked up. And now the manufacturer whistles a happy tune. Why not? His petroleum jelly is a popular first choice everywhere.

Highly trained technicians will test your product without obligation in a Cherry-Burrell laboratory. They will show you how Cherry-Burrell food processing equipment can help you improve your operation and profit position. Your specialists are invited to participate in the testing. Call or write Cherry-Burrell today.

**Case history on request.*

Equipment for homogenizing, heating, cooling, flavorizing, storing, separating, freezing, mixing, packaging and conveying. Write for your free catalog.

CHERRY-BURRELL
CORPORATION
CEDAR RAPIDS, IOWA



FULLER PNEUMATIC CONVEYING SYSTEMS INCREASE PRODUCTION, CUT CONTAMINATION FOR GOODYEAR

Recent installation of specially engineered Fuller Airveyor® pneumatic conveying systems to handle pelletized rubber has helped Goodyear Tire and Rubber Company increase production. These systems are the latest Fuller design resulting from over 15 years experience in pneumatic conveying of rubber pellets. These completely enclosed automatic systems virtually eliminate contamination problems and greatly reduce the chance of loss due to spoilage.

Automated handling of crude rubber with Fuller Pneumatic Conveying Systems, in place of conventional rubber slab sheeting on a mill, is the key. One Airveyor system conveys the pelletized rubber from the pelletizer to a weigh station, a distance of 500 feet. Four more systems operate from the sink dump scales to inlet spouts of the finish-run Banburys.

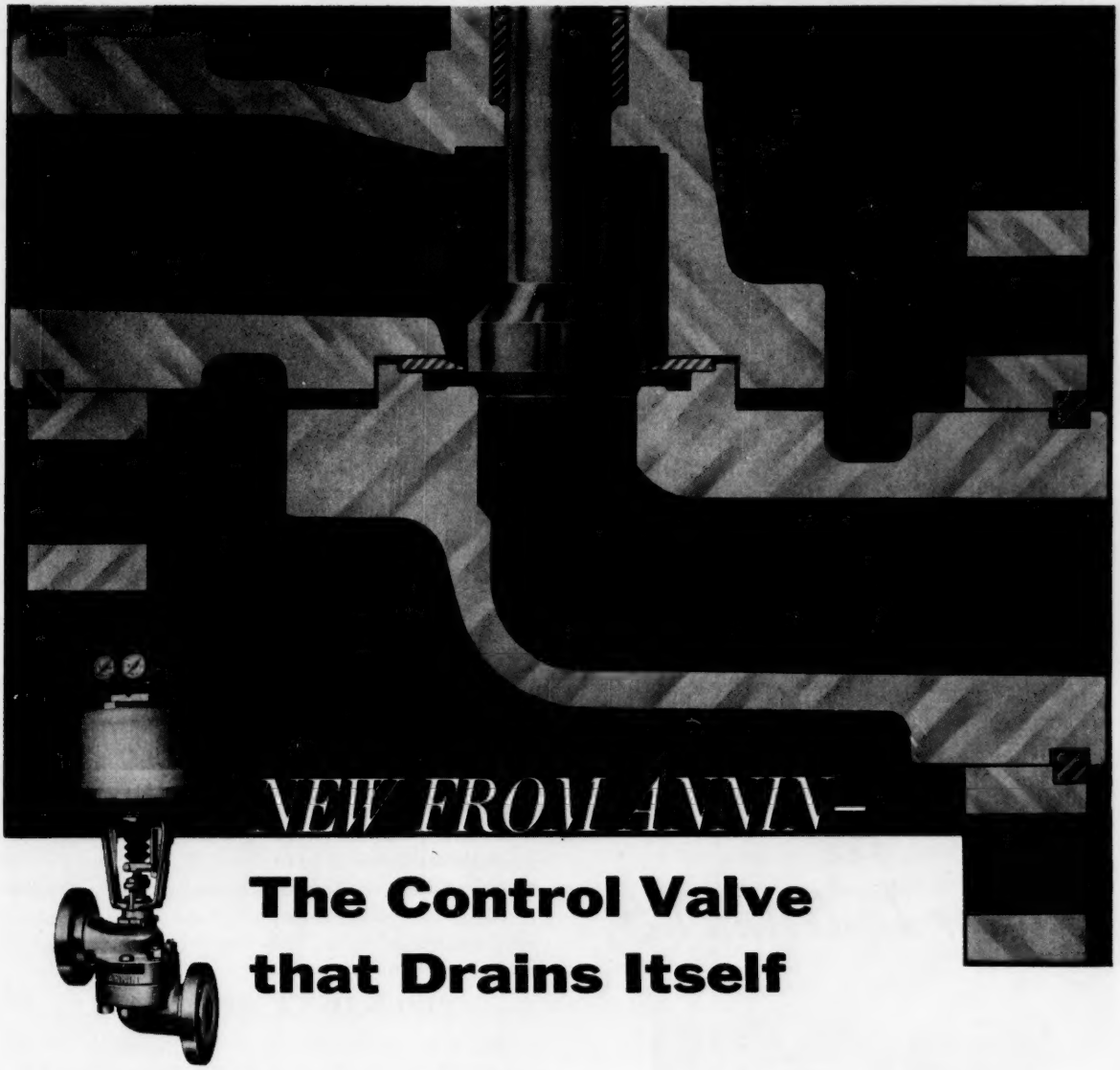
All of these Airveyor pneumatic conveyors are of the vacuum type, employing positive pressure exhausters for air supply. Each conveying system is equipped with its own individual bag-type filter, automatic in operation, which provides for 100% visible dust retention. Exhausters and filters are located on the roof. A control panel permits manual or automatic operation of the entire handling system.

If you are handling dry, bulk, granular materials, a Fuller Conveying System application-engineered to your process can be equally advantageous. Look to Fuller, whose range of products coupled with experienced know-how offers you the best *single source* for solving pneumatic materials handling problems. Just call or write Fuller today outlining your problem—no obligation, of course. A-288 1954

"See Chemical Engineering Catalog for details and specifications"

FULLER COMPANY
134 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
... pioneers in harnessing AIR

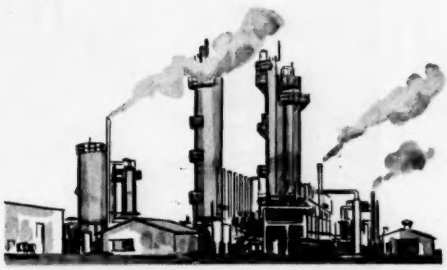


NEW FROM ANNIN—

The Control Valve that Drains Itself

ANNIN'S MODEL 1900 SELF-DRAINING CONTROL VALVE is designed to completely drain the line and valve body of corrosive fluids, slurries, and other flowing media which contaminate or tend to set up and harden in the system. Body and trim are designed so that all surfaces slope downstream, making the valve completely self-draining when installed in either the horizontal or vertical position. All body parts are interchangeable with other Annin models, allowing an option of globe, angle or three-way body patterns. Model 1900 is designed to accept all standard actuators—Pneumatic Domotor, Electro-Pneumatic, Electro-Hydraulic, Cylinder or Manual.

Send for latest technical information.

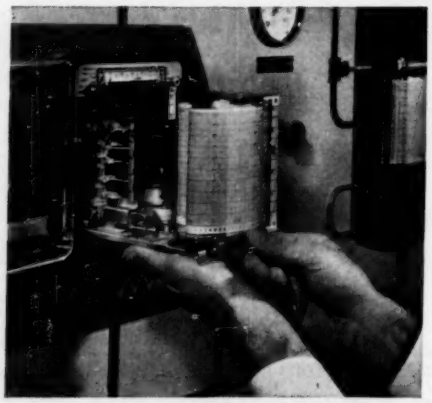


Model 1900 has many applications in the process industries, both in batch operations which require cleansing of the system after each run and in continuous processes after the system is shut down. Unique self-draining design of the valve body eliminates problems of fluid contamination, fermentation, toxicity and solidification.

Annin VALVES

THE ANNIN COMPANY
1040 South Vail Avenue,
Montebello, California

ANOTHER Money Saving Feature OF *Taylor Instruments*



"PLUG-IN" CONVENIENCE

Pioneered by Taylor ten years ago, the "plug-in" idea applies both to complete instruments and to components. For example, TRANSCOPE® Controllers plug-in to the backs of Recorders and Indicators and component parts plug-in to main assemblies. It is a dependable design feature of both the pneumatic and the electronic lines of TRANSCOPE instruments, proven by ten years' field experience.

Here are some of the important ways you benefit from this Taylor feature:

PLUG-IN INSTRUMENTS

- **Faster installation**—because housings with manifolds can be installed and connected while recorder and controller mechanisms are being manufactured.
- **Interchangeability of instruments**—a recorder can be quickly substituted for an indicating receiver when process trends need to be studied.
- **Minimum process interruption**—because a faulty instrument can be replaced in seconds.
- **More efficient maintenance**—instruments that require servicing can be taken to the shop, where complete facilities are available. This also means fewer highly skilled personnel are needed.

PLUG-IN COMPONENTS

- **Continuous control,** even when any one of the major assemblies is removed from the electronic recorder or controller, or the pneumatic recorder.
- **Quick conversion** for use with different primary elements, in the case of the 700T Potentiometer Transmitter. Just plug in the appropriate service "can".

* * *

Plug-in is another example of Taylor engineering ingenuity . . . of attention to detail that saves you money, gives you better process control. See your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester, New York, or Toronto, Ontario.

Taylor Instruments
MEAN ACCURACY FIRST

NEW CALSILITE-HI® HANDLES SOAKING 1800°F

Light, strong and economical, new Calsilite-Hi is ideal for both insulation and fireproofing where temperatures run over 1250°F up to 1800°F. For lower temperatures than these, Ruberoid's Regular Calsilite® insulation is recommended.

Both Calsilite and new Calsilite-Hi are molded calcium silicate insulation. They're light and easy to install. They cut and mitre quickly, smoothly. They're gentle on hands. They stay strong when wet, won't soften or fall off, return to original thermal efficiency when dry. They resist most industrial chemicals and alkalies. Available in half sectional, three segmental and block form.

For additional information, specifications, and free samples of new Calsilite-Hi or regular Calsilite insulation, mail coupon now.

RUBEROID®

Industrial Products Division CE-3-20
The RUBEROID Company
500 Fifth Avenue
New York 36, N. Y.

☐ Please send technical bulletin with specifications
☐ Please send sample of Calsilite-Hi
☐ Please send sample of regular Calsilite

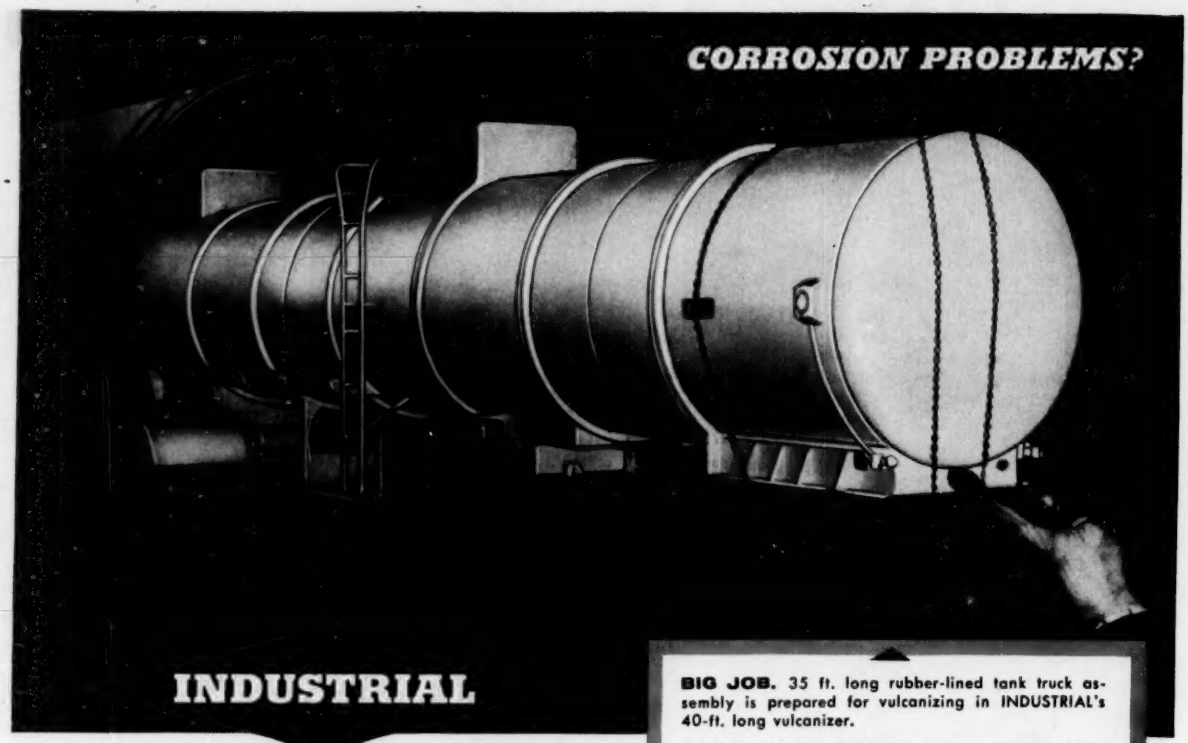
Name_____

Title_____

Company_____

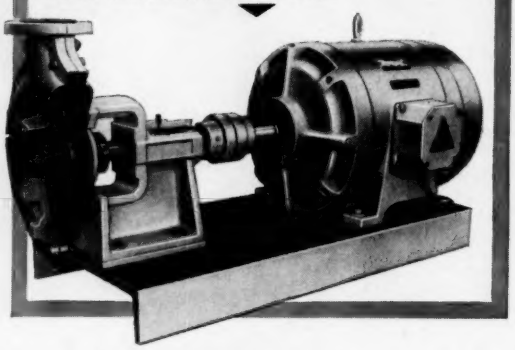
Address_____

City_____ Zone___ State_____



BIG JOB. 35 ft. long rubber-lined tank truck assembly is prepared for vulcanizing in INDUSTRIAL's 40-ft. long vulcanizer.

SMALL JOB. INDUSTRIAL rubber-lined Centrifugal Pumps give long life with minimum maintenance on the most severe corrosion service.



For Skilled Rubber Surfacing

. . . these complete facilities insure a *better* job at *lower* cost

INDUSTRIAL operates one of the largest rubber compounding and lining plants outside of the rubber industry. Here, tons of raw rubber are maintained in stock for formulating and compounding into compression molds and rubber linings to meet the *most specific* corrosion or abrasion-resistant services.

This extensive facility permits INDUSTRIAL to maintain the highest standards of quality control for rubber-lined processing equipment designed and built by INDUSTRIAL. In addition, it also provides a skilled, experienced and well-equipped source for *custom* sheet lining and compression molding to meet individual requirements.

All the benefits of INDUSTRIAL'S experience in designing, engineering and producing rubber components, and for applying it to the most intricate surfaces, is described in our RUBBER DIVISION bulletin. Write for your copy, today.

INDUSTRIAL Centrifugal Pumps are specifically designed for rubber lining. **As a result, they characteristically provide long, trouble-free life in corrosive or abrasive service . . . offering these design benefits:**

- **Mechanical Seal or stuffing box**
- **Easy access to pump seal**
- **Quick adjustment of impeller clearance**
- **Teflon seal cage (stuffing box only)**
- **Impeller insert welded to shaft**
- **One-piece, maintenance-free rotating element**

INDUSTRIAL

INDUSTRIAL FILTER & PUMP MFG. CO.
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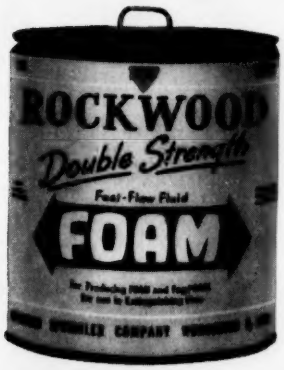
99.7%

of Rockwood FOAM protection is FREE!



ROCKWOOD SPRINKLER COMPANY

A Division of The Gamewell Company
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Engineers Water . . . to Cut Fire Losses

FOR FIRE FIGHTING purposes Rockwood Double Strength FOAM is inexpensive and completely effective. 3 parts *Rockwood Foam Liquid, plus 97 parts free water, plus 900 parts free air give you a fast low-cost fire extinguishing agent for only 1½ cents a gallon!*

Rockwood Double Strength FOAM puts out fires fast . . . reduces your storage costs . . . reduces shipping costs too! If you're using other types of special hazard fire extinguishing agents — you may not be using the most economical or most effective agent! We'll show you how to save on training cost and on fire fighting costs — and to fight fires better! Send in the coupon below. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal cities.

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Department
530 Harlow Street, Worcester 5, Massachusetts

Please send me complete information on Rockwood fire-fighting products.

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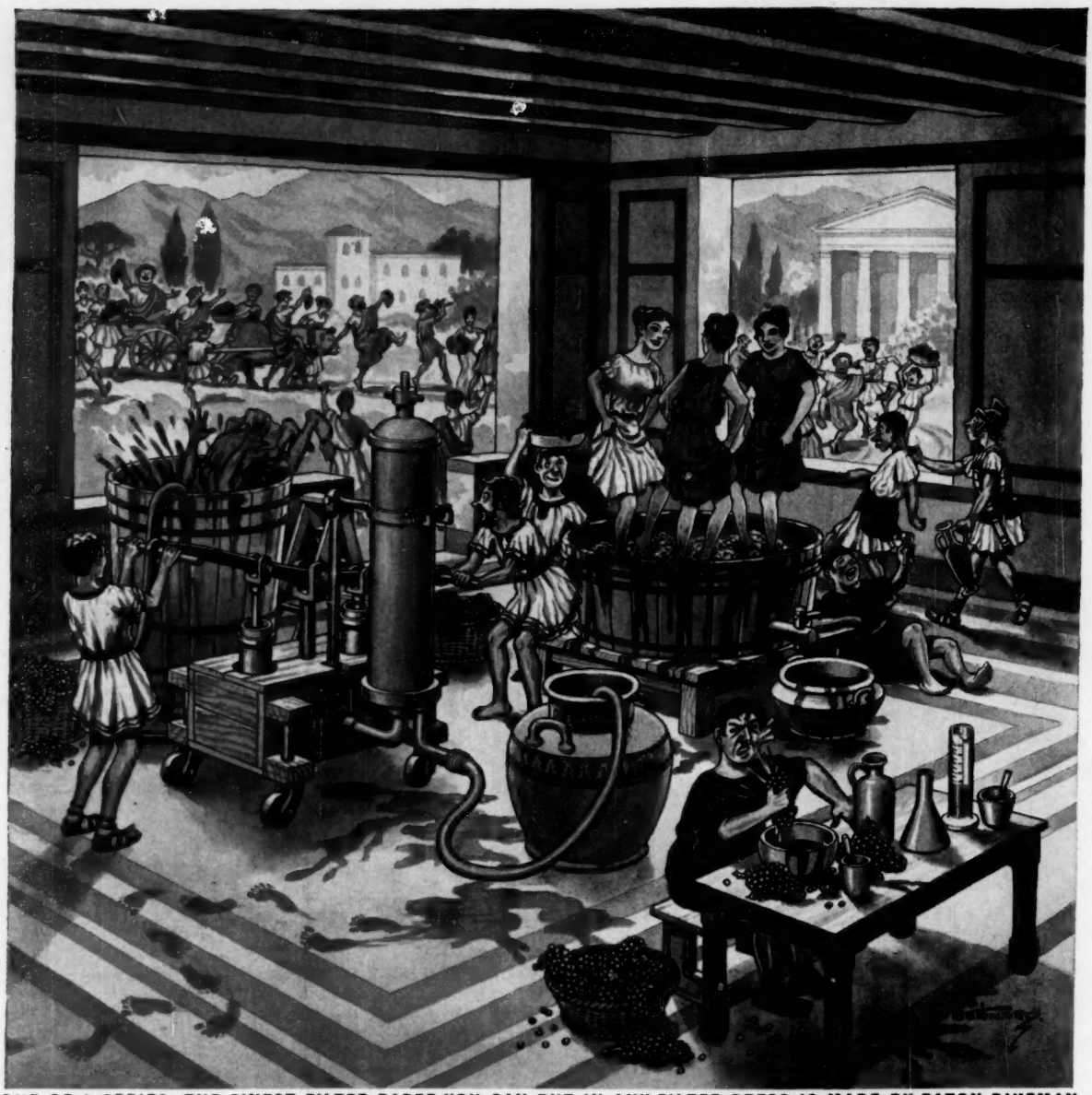
Title.....
Company.....
Street.....
City.....*Zone*....*State*.....



ONE OF A SERIES: THE FINEST FILTER PAPER YOU CAN PUT IN ANY FILTER PRESS IS MADE BY EATON-DIKEMAN

Nobody comes close to matching E-D's experience in industrial filter papers. We're the only company in America engaged exclusively in the manufacture of filter paper for science and industry. We sell it custom-tailored to your process and your press — cut to your size, folded, punched or made into pads . . . with the right combination of characteristics, including wet strength, flow rate, particle retention, weight, and thickness — to help you achieve maximum filtering efficiency and economy. **And when it comes to technical help and service:** at all times, the experience of E-D engineers, technicians and distributors is available to you . . . to help you in the selection of the right E-D paper for your specific application. **Our 24-page catalog on industrial filter papers gives complete details. Just write for Catalog 357.**

THE EATON DIKEMAN COMPANY
Filtertown, Mount Holly Springs, Pennsylvania

Every major filter press manufacturer in America recommends Eaton-Dikeman filter papers.

NEW SYNTHETIC PAPER — Eaton-Dikeman is producing a 100% Dacron paper which is made by the new Du Pont textryl technique. It is very strong, is chemical and heat resistant, and picks up very little moisture. Samples of several weights are available for filtration as well as other uses in the chemical industries. Paper of Orlon and Nylon can also be made by the same technique. Write today.

WHEN YOU BUY TIMKEN® STEEL PRESSURE TUBING, you're sure of fine forged quality in the tube itself and an exceptional inner surface that assures maximum tube life per dollar.

For almost every condition of corrosion, pressure or temperature, there's a Timken seamless steel pressure tube. Timken seamless tubing is available in all common carbon, alloy and stainless grades, up to 11″ O.D. and with wall thickness up to 3¼″.

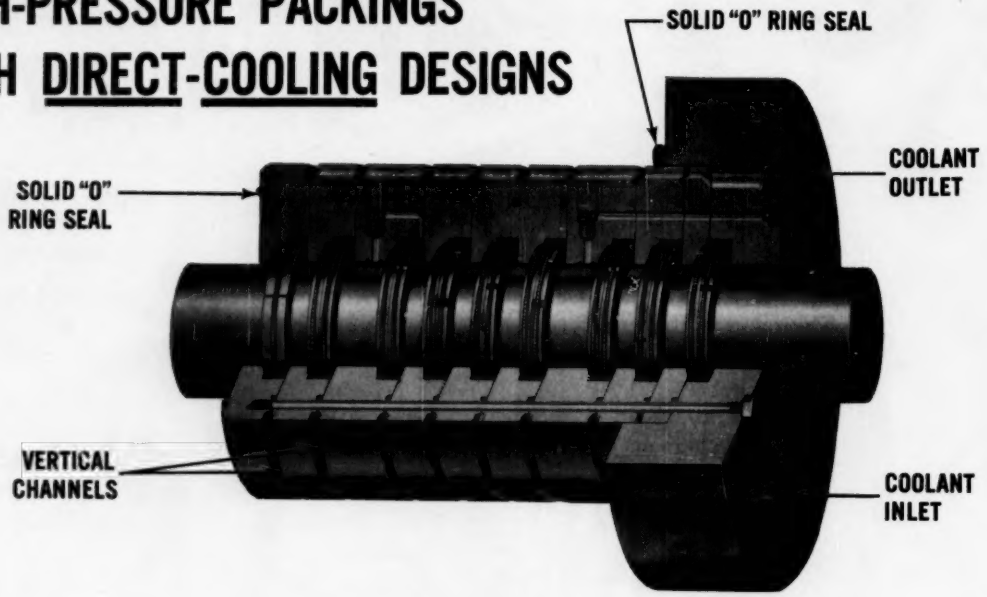
Our expert metallurgists will be happy to work with you to help you select the one tube that will give you maximum tube life per dollar. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
FINE ALLOY STEEL

ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

COOK TAKES HEAT OFF HIGH-PRESSURE PACKINGS WITH DIRECT-COOLING DESIGNS



Here is a packing that keeps cool *even at pressures up to 50,000 pounds per square inch.* It's one of Cook's new packings for high-pressure applications —typical of recent advancements in direct-cooling packing design.

Connections for the coolant are handled easily without arranging separate inlets or outlets through the stuffing box. Coolant enters a trunk line at the bottom of the packing, then completely encircles the case through a series of multiple vertical channels. Heat from the high-pressure packing is carried off by the coolant through the outlet trunk line at the top of the packing.

But direct cooling is not limited to new designs. Cook's creative design engineering provides almost unlimited possibilities for direct cooling, even on existing packings.

WRITE FOR MORE INFORMATION

If you want Cook engineers to review the special requirements of your specific high-pressure packing application, just write C. Lee Cook Division, Dover Corporation, 958 South Eighth St., Louisville 3, Kentucky. Or send for information about Cook's complete line of rings and packings.

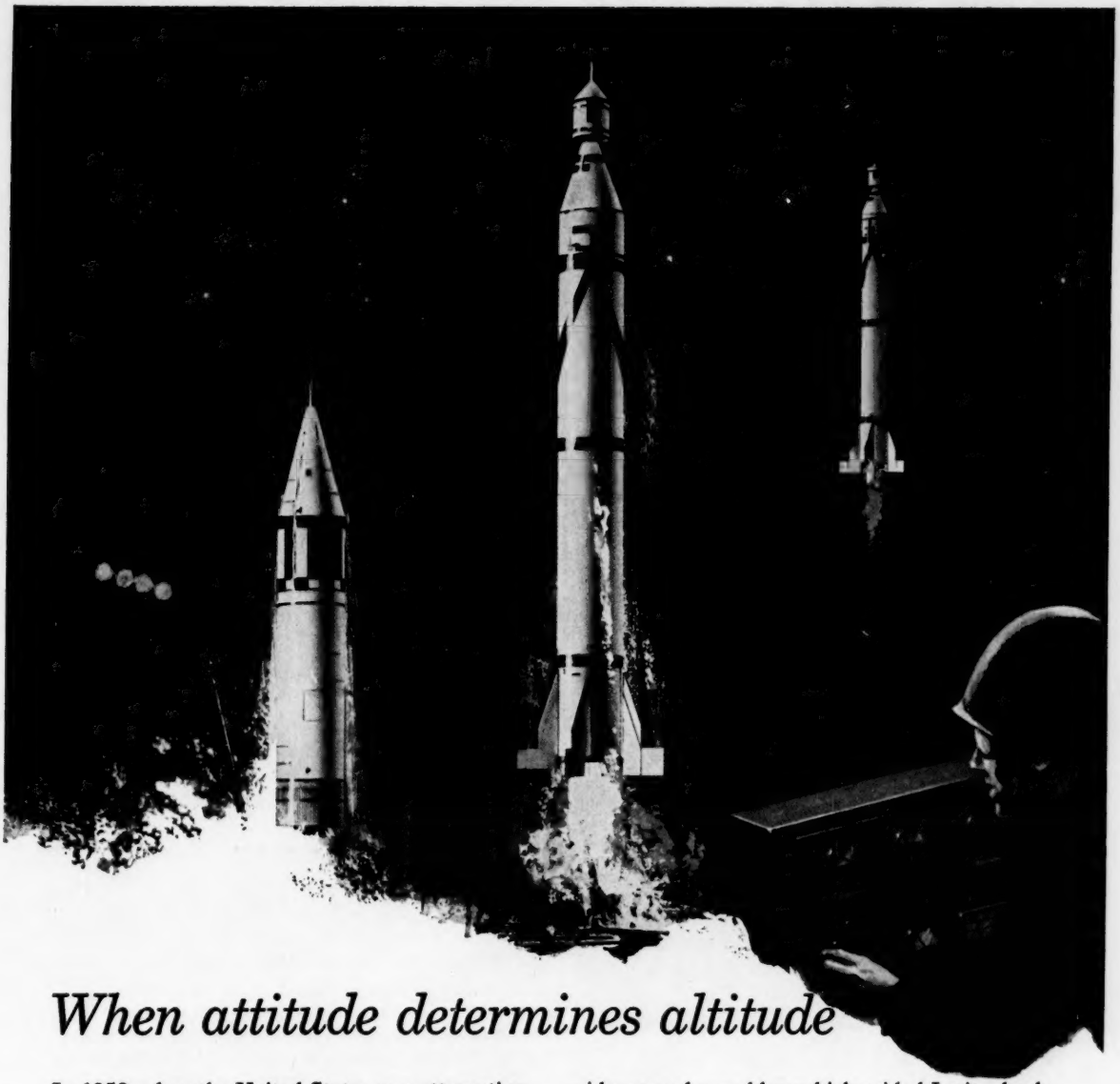
COOK SEALS LIQUIDS AT EXTREME PRESSURES AND TEMPERATURES

C. Lee Cook has unique experience in the advancement of liquid-seal technology. Recently completed research and development contracts (one with a major airframe and missile manufacturer) have resulted in new concepts of seal design, materials compatibility, friction limitations and sealing efficiency. If yours is a special packing application, call in a Cook representative.

C. LEE COOK

DIVISION OF DOVER CORPORATION

Rings and Packings Since 1911



When attitude determines altitude

In 1958, when the United States was attempting to put its first satellite in orbit, the Jupiter missile was selected as the power plant for one of the shoots. The Jupiter had the power required and the direction control to maintain the precise angle of ascent so the final stage would reach the desired altitude.

To achieve this control, small gas generators, fueled by Becco 90% H_2O_2, were clustered around the body of the missile. Jets of oxygen, generated by H_2O_2, and steam spouting from the sides served as rudders which guided Jupiter back on the desired path whenever it began to stray. Result: Explorer I had the proper attitude and went into a precise orbit at the proper altitude.

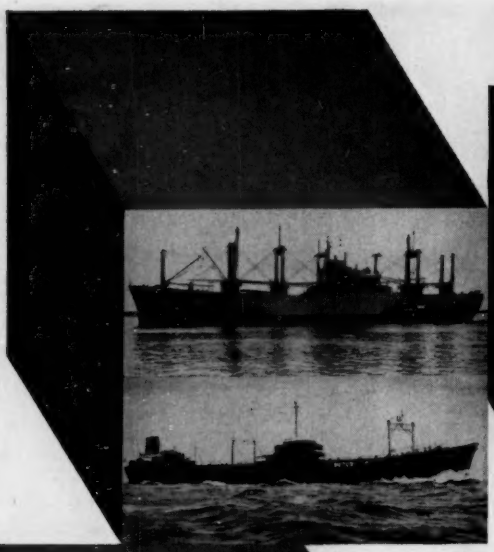
Becco H_2O_2 serves in other fields, too—as a bleach in textile and paper manufacture, as an etch for transistors, and as an oxidant in many chemical reactions. Becco, with more years of manufacturing experience than any other peroxide manufacturer, can supply you with more information about its many properties. Address: Dept. CE-61-3.

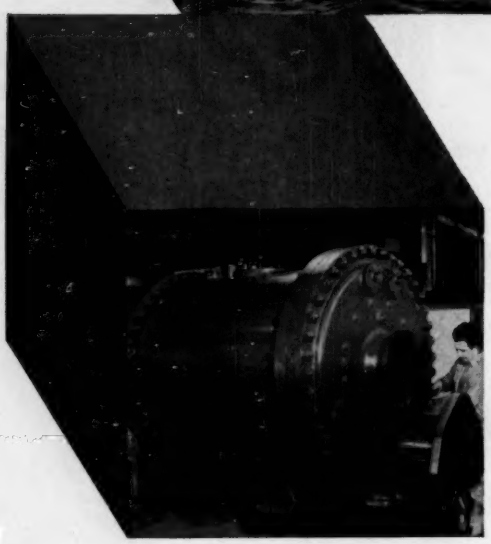
BECCO Hydrogen Peroxide

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
Becco Chemical Division

General Sales Offices:
161 EAST 42nd STREET, NEW YORK 17, N. Y.





SUN SHIP built 'em all....

Our reputation as "master builders for land and sea" is based on 44 years' service to the oil-refining, chemical and other industries.

Frequently we are called upon to produce components for the building of large plants. Our manufacturing and fabricating skills, our understanding of industry's problems are reflected in the variety of equipment we build, like the fractionating towers and special pressure vessel shown here.

In our complete, modern shops we build and *deliver* what's needed in many fields. Our special Alloy Products Shop, for example, is equipped to produce medium and heavy stainless alloy and aluminum products for industry.

Building for land • Pressure vessels • Fractionating towers • Stills and tanks • Condensers and similar equipment • Special machinery • Plate work, etc.

Building for sea • Dry cargo ships • Tankers • Marine repairs • Dredges • Ferries • Marine engines • Marine machinery.

Sun Ship does a big job for many companies, and can do the same for you.

Sun

SHIPBUILDING & DRY DOCK COMPANY

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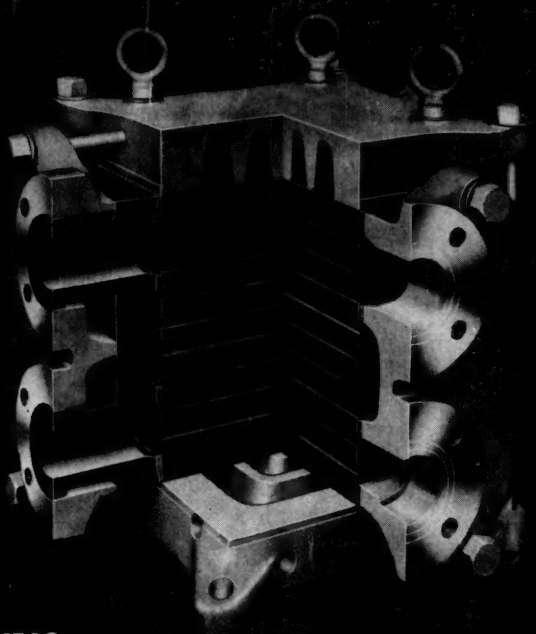
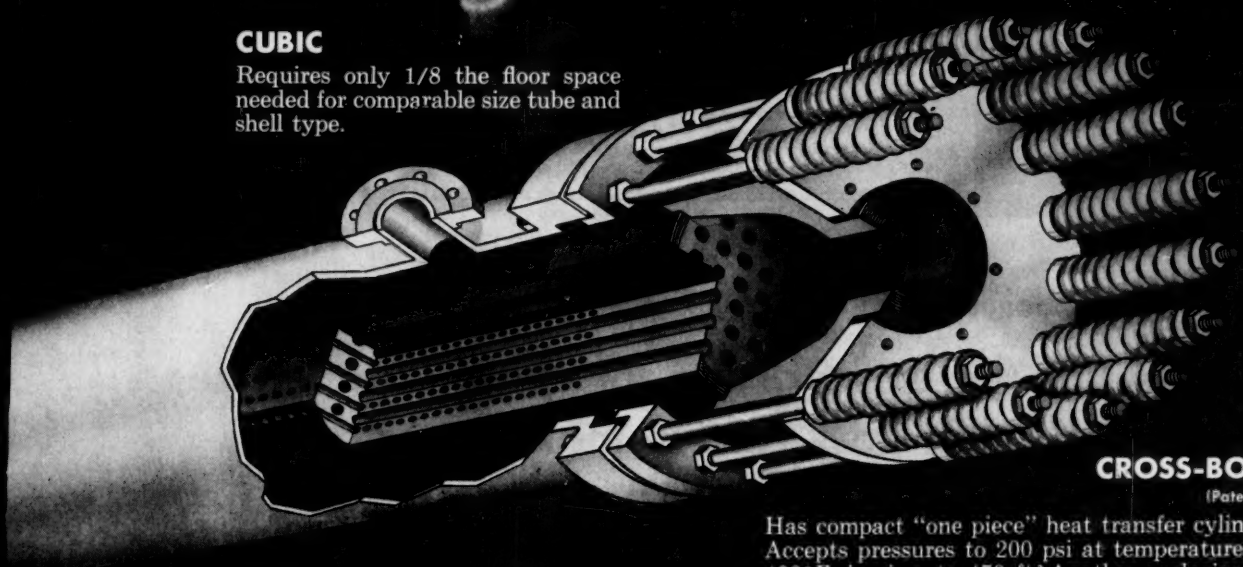
TAKE YOUR CHOICE
from FALLS INDUSTRIES

RELIABLE CORROSION-PROOF IMPERVIOUS GRAPHITE EXCHANGERS



CUBIC
Requires only 1/8 the floor space needed for comparable size tube and shell type.



CROSS-BORE
(Patented)
Has compact "one piece" heat transfer cylinder. Accepts pressures to 200 psi at temperatures to 400° F. in sizes to 470 ft.² Another exclusive development from Falls Industries.

These exchangers are unaffected by all corrosives except a few highly oxidizing agents — are immune to thermal shock — resist effects of internal and external shock — possess a high rate of thermal conductivity (over five times greater than stainless), . . . and are available at a surprisingly low cost! Write for 32-page Industry-Service report, "Data for Cost Estimation", which provides standards and costs for 16 standard types of impervious graphite equipment.

FALLS INDUSTRIES, INC.
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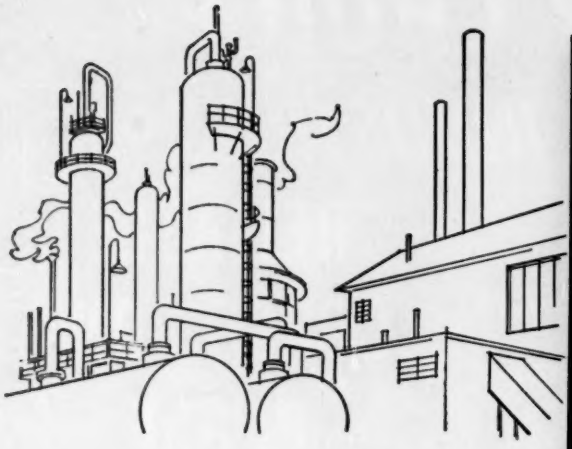
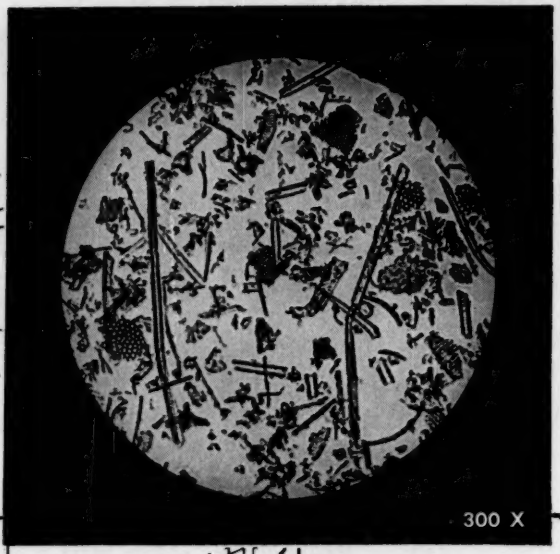
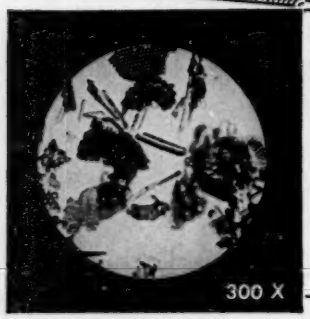
PRODUCERS OF BETTER PROCESSING EQUIPMENT FROM IMPERVIOUS GRAPHITE

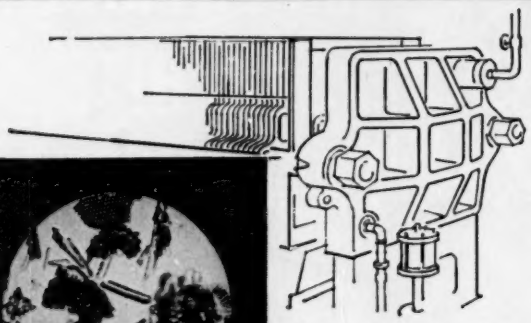
Cubic, Tube and Shell, Cross-Bore, Parallel and Modular Heat Exchangers; Immersion Plate Heaters; Cascade Coolers; HCl Absorbers and Plants; Towers; Centrifugal Pumps; Ball, Control, Drain, Angle, and Diaphragm Valves; Rupture Disks; Pipe and Fittings; Crucibles; Thermowells.



For flow rate plus clarity—Hyflo Super-Cel has the right combination of large and fine particles. Heavily used in chemical processes such as caustic soda production.

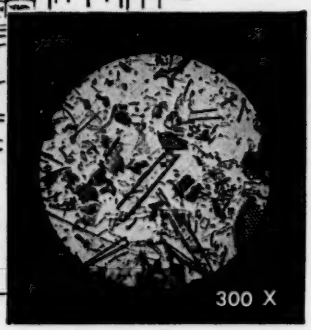






For fast flow rates—Celite 545 has a higher proportion of coarse particles. Frequently used for clarification of resins and other viscous liquids.

For maximum clarity—Filter-Cel has a relatively fine particle size distribution. Used in producing lard, salad oil, other hydrogenated oil products.



In diatomites, Johns-Manville precision processing works for you

Celite has the exact grade for every filtration need from fast flow rate to maximum clarity

Study samples of various filtration grades of Celite* diatomite with the unaided eye. Rub them between your fingers. One grade looks, feels very much like another.

Then compare these grades under the microscope. Each has its own distinctive particle size distribution. Each is precision-milled to fill the most exacting filtration requirements, ranging all the way from maximum flow rate to maximum clarity.

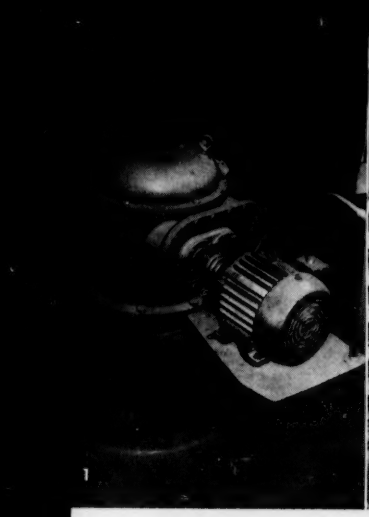
Celite 545, for example, with a higher proportion of large to fine particles, is used to remove large suspended impurities at maximum flow rates. *Hyflo Super-Cel®* has a balanced particle size distribution, combines good liquid clarity and moderate flow rate. But *Filter-Cel®* has a much higher ratio of small particles, is tailored for use where high clarity outweighs flow rate.

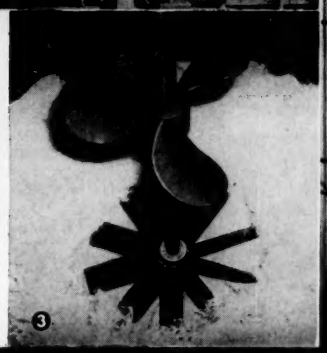
Whatever your filtration problem—Johns-Manville can furnish the "right" grade for the job. You have a choice of 9 intermediate grades *plus* many special grades. Each comes from the largest and purest commercially available deposit. Each is processed and graded at the same plant under the same uniform conditions.

For information on specific filtration or mineral filler problems, talk to your nearby Celite engineer, or write to us. Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products

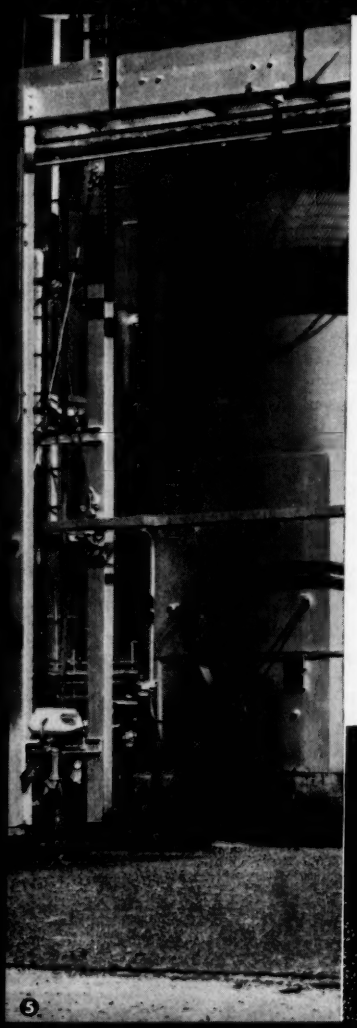
JOHNS-MANVILLE JM PRODUCTS





1. Ore purification in pressure vessel with Nettco tank top turbine mixer.
2. Butadiene blending with Nettco side drive mixers having replaceable, mechanical seals.
3. Violent agitation as produced by Nettco's unique combination of turbine and propeller drives.
4. Maintaining product uniformity in Styrene storage tanks with Nettco side drive mixers.
5. Blending with Nettco side drive mixer in storage tank containing 20% caustic solution.
6. Small batch blending with versatile Nettco portable mixer.
7. Standardization of finished product with rugged Nettco vertical turbine mixers.

Improved Processing through Engineered Agitation



WHAT'S THE BEST MIXER FOR YOUR PARTICULAR JOB?

FLUID MIXING demands specialized, highly technical know-how. There is no single mixer which is "best" for every job. Only a mixing specialist can combine and coordinate agitation technology with mixer design and optimum horsepower to achieve an exacting result.

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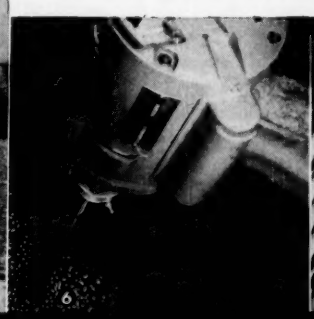
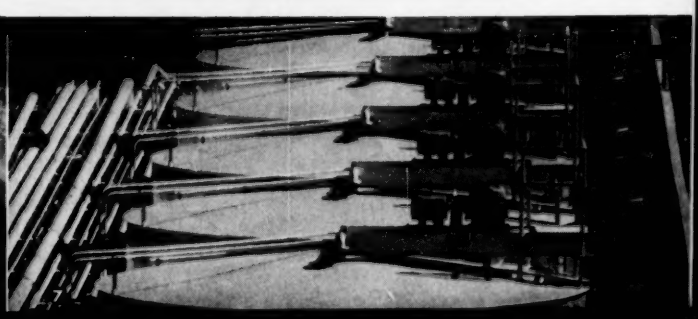
BACKED BY A FULL LINE . . . side drive, tank top, portable or tripod and continuous pipeline mixers . . . and thousands of performance-proven installations, like those illustrated, NETTCO can provide invaluable help in determining your fluid mixing needs. See *Chemical Engineering Catalog* or *Refinery Catalog* for our nearest representative, or write for Bulletin 582, NETTCO CORPORATION 87 Tileston Street, Everett 49, Massachusetts.

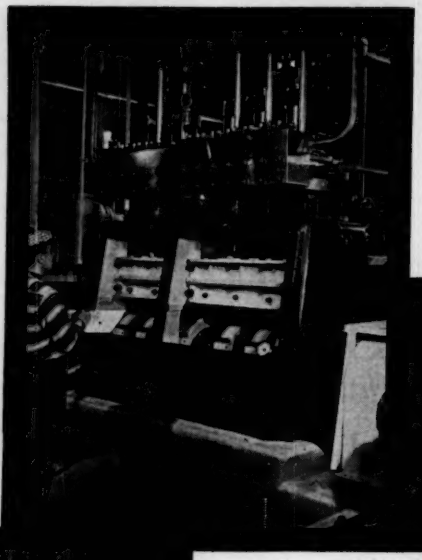
NETTCO

ENGINEERED AGITATION SPECIALISTS

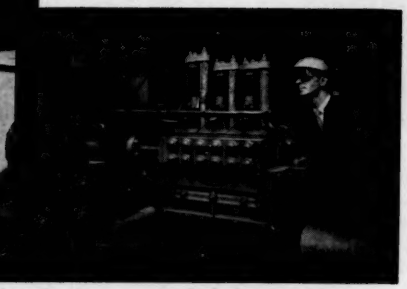




WHAT'S YOUR SPECIAL PROBLEM IN PUMPING?



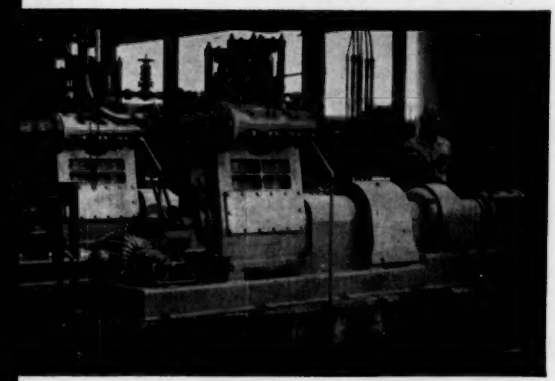
Special nylon ball valve and stainless steel fluid end handle silica gel at 1800 psi.

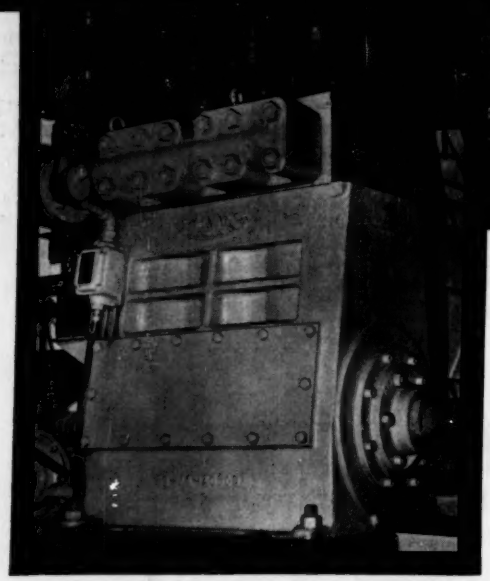


Here, Aldrich pumps continuously control the flow of liquid ammonia at 3700 psi.

This Aldrich pump handles highly corrosive chemicals—both alkaline and acidic.

Aldrich pumps with nickel alloy fluid end pump 50% caustic soda solution at 400 psi.





To handle, alternately, caustic and brine, at 3000 psi, this Aldrich Triplex pump has entire fluid end of Monel.

Corrosives? Slurries? High pressures? High temperatures? We'll find the answer!

All pump companies sell pumps. And all have their share of pumping problems. At Aldrich, our most important stock in trade is our ability to solve the rough pumping problems of the process industries. We've had over 50 years of working with chemicals and chemical processes. We know the problems of pump wear; of temperature, corrosion, viscosity; and your need for sustained pump operation. We study all the factors in your problem, in depth . . . and come up with a *better* answer, not merely *an* answer. For information on capacities, pressures and sizes, see our insert in *Chemical Engineering Catalog* or write for reprint (Data Sheet 100). ALDRICH PUMP COMPANY, 3 Gordon Street, Allentown, Penna.

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ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

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The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

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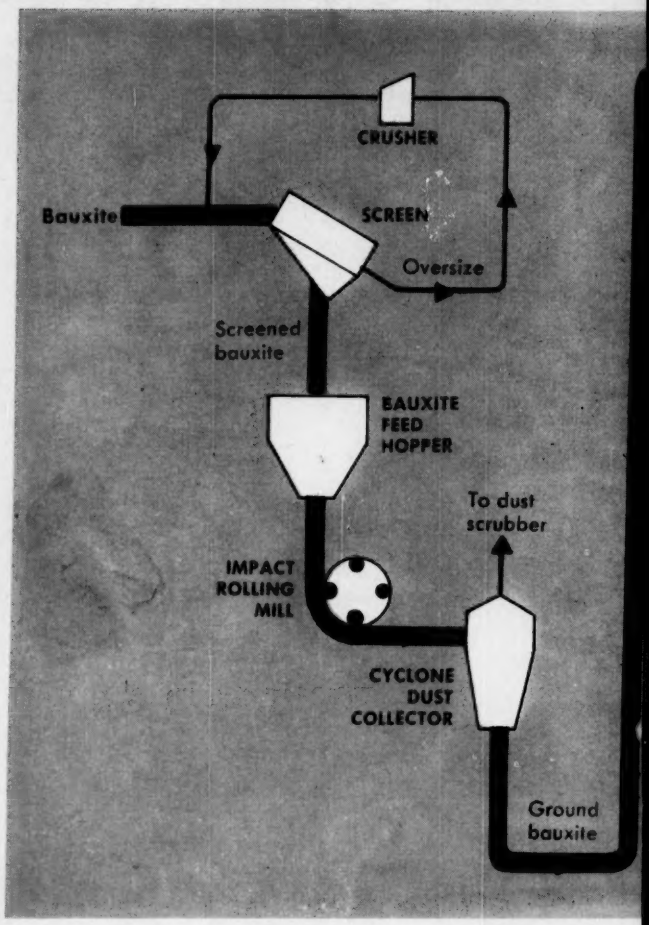
Process Flowsheet



Dixon Chemical & Research is turning out alum in a new facility at Newark, N.J., that aptly ties in with the firm's adjacent sulfuric acid operations. Here CE gives you an

Inside View Of a Modern, Complete Alum Plant

E. K. SHELDON
Editorial Assistant

At Newark, N. J., last June, Dixon Chemical & Research, Inc., put on stream what is believed to be the most modern and complete alum plant ever built. Facility is designed to turn out the equivalent of 120 tons/day of 17%–Al_2O_3 aluminum sulfate; about half of this is sold as liquid, the rest is marketed as solid grades of various meshes.

Designed and erected for Dixon by The H. K. Ferguson Co., New York, the plant employs batch operation. This is in keeping with current practice in alum production because, although Chemical Construction Corp., New York, has developed and is seeking buyers for a new continuous route, and a few continuous-process plants went into operation around 1930, alum manufacture continues to be essentially a batch procedure.

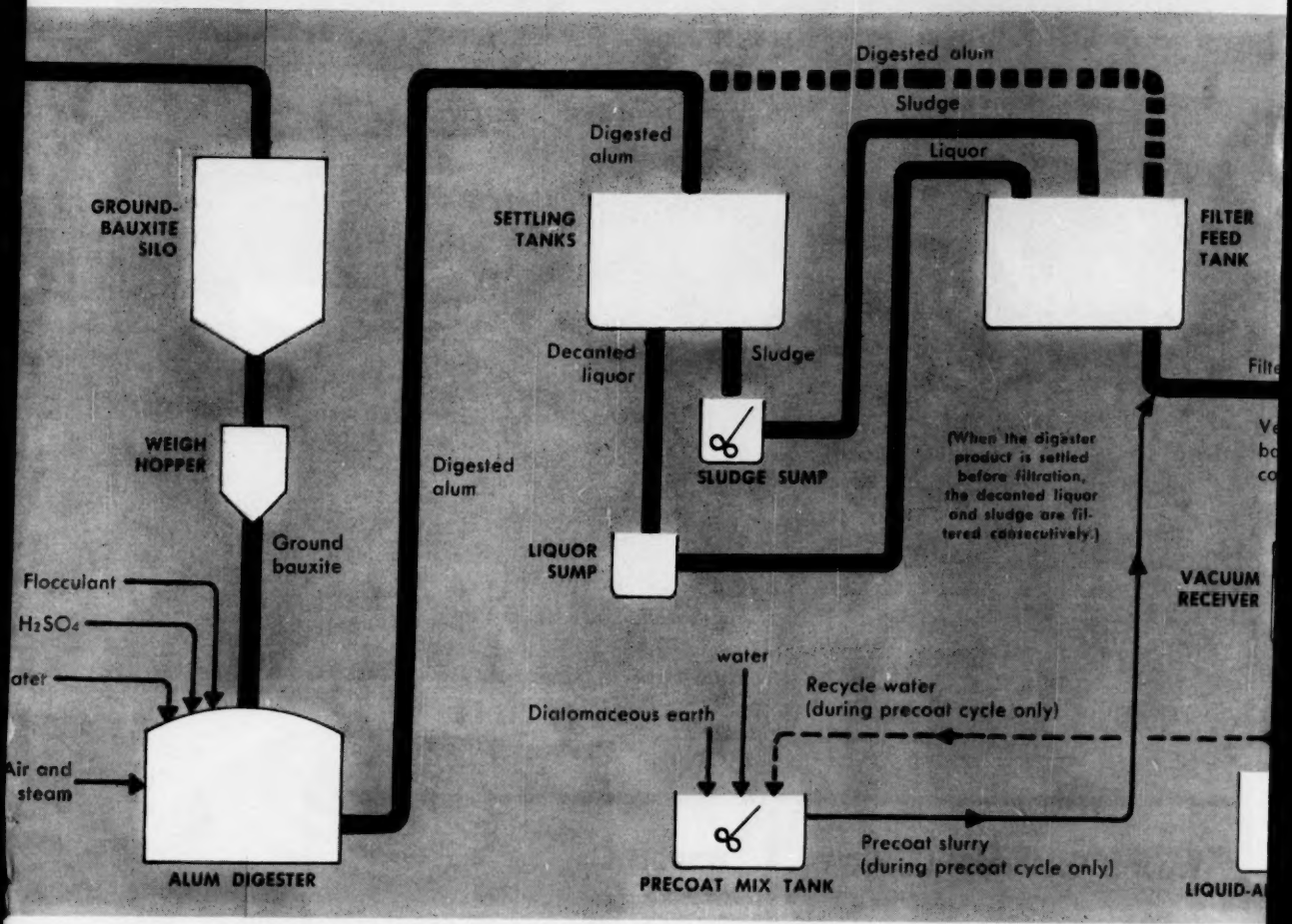
Dixon's alum operations are housed in a single 120 x 200-ft. building that is partitioned into three sections. One contains equipment for preparation of raw-material bauxite, one houses facilities for bauxite digestion and subsequent separation of liquid alum, and the third is used for production and handling of finished solid grades. This arrangement helps keep bauxite dust away from clear liquor, and moisture from the finished solid alum.

▶**A Summary View**—The basic chemical reaction behind alum production is

$$Al_2O_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2O$$

At Dixon's plant, this reaction takes place in a brick-lined digester 20 ft. in dia. and 18 ft. deep. Digester feed is bauxite, which has been ground, and sulfuric acid from a nearby Dixon facility.

Unfold flowsheet



Digester effluent is subjected to filtration, usually preceded by settling, to separate liquid alum from the inert mud content of the raw-material bauxite. Part of the clear liquor is sold as such; the rest is concentrated in an evaporator, then solidified, crushed and screened for sale as solid. Dixon offers its solid product in one "lump" grade, several "ground" grades.

Plant operates at conversion efficiencies of about 90%. And Dixon takes care to keep a tight material-balance around its bauxite processing; discarding of cake from the filter is the only point in the process where unwanted constituents of the bauxite feed are removed.

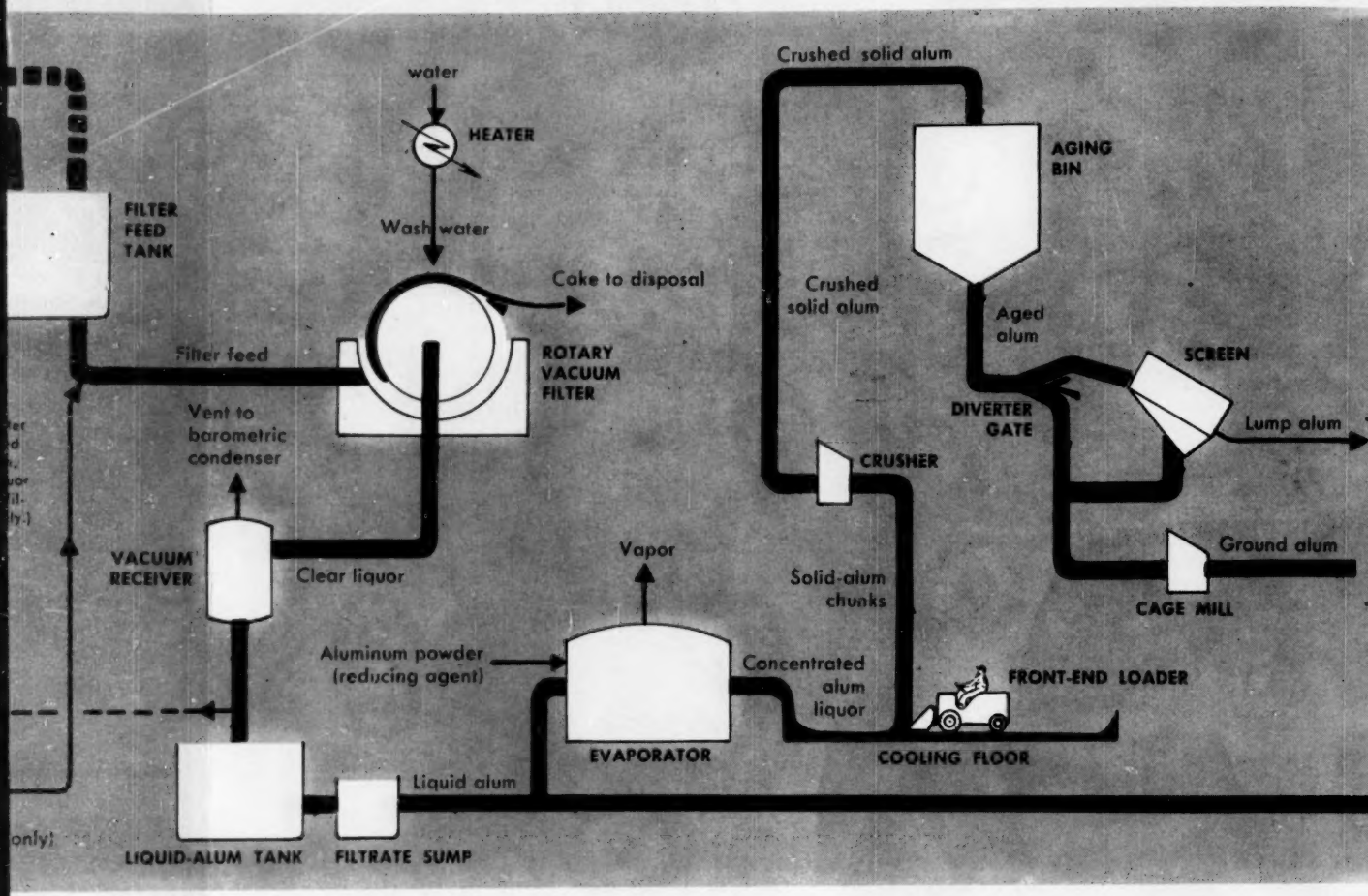
▶**Start With Bauxite**—Bauxite is delivered to Dixon's Newark site by ship, stored there in a 2,000-long-ton holding bay. As a first step in preparing the bauxite for digestion, it is screened and the oversize is recycled through a crusher, thus reducing all of the ore to minus-¾-in. dimensions.

Next step is to further reduce the material in an impact rolling-mill. Mill output, 80% of which is minus-100 mesh, passes through a cyclone separator to an 80-ton storage silo, and from there it is conveyed as needed to a weigh hopper above the digester.

▶**Digestion**—A given digestion operation is started by feeding 5,800 gal. of water to the digester, followed by 4,200 gal. of 93% sulfuric acid. Live steam is added until temperature reaches 245 F.

A total of 19 tons of bauxite is added gradually, while temperature is maintained at 240—245 F. Operators test the batch for reaction completion and for basicity (excess Al_2O_3 over the amount combined as $Al_2(SO_4)_3$), and when the digestion is completed, more cold water is added and batch temperature is brought to 180 F.

▶**Liquid Handling**—Digester effluent—24,000 gal./batch, two batches/day—is pumped to one of a group of unlined, open, cypress tanks. At this point, either of two treating alternatives can be followed: the entire, unsettled batch can go di-



...tput, 80% of ...es through a ...rage silo, and ...ed to a weigh

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...t—24,000 gal./ ...d to one of a ...anks. At this ...natives can be ...ch can go di-rectly to the filter, or the batch can be first settled and the resulting sludge and liquor filtered separately.

The filter is a rotary vacuum unit, 5¼ ft. in dia. and 10 ft. long. Before each batch is handled, the filter is given a precoat layer of diatomaceous earth. During filtration, the mud cake is washed with hot water.

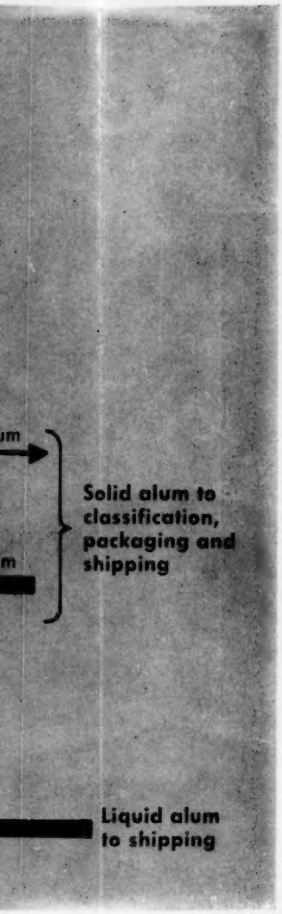
The cake is discarded and the clear alum filtrate is sent to one of the cypress tanks for holding. From this tank, it can be pumped to truck or rail loading racks for sale as liquid (containing 8.3% Al_2O_3) or it can be sent to the solids-production section of the plant.

▶**Making Solid Grades**—Evaporation is the first step in converting the liquid alum to solid grades. This takes place in a brick-lined, steel tank containing 1,500 ft. of 1½-in. coils for 100-psig. steam. A 4,000-gal. batch of liquor is fed to the evaporator. The evaporation cycle lasts 4 hr., and concentrated liquor product (containing 17% Al_2O_3) is then allowed to spread out over one of two 1,000-sq. ft. cooling floors. One batch from the evaporator represents 10 tons of finished alum.

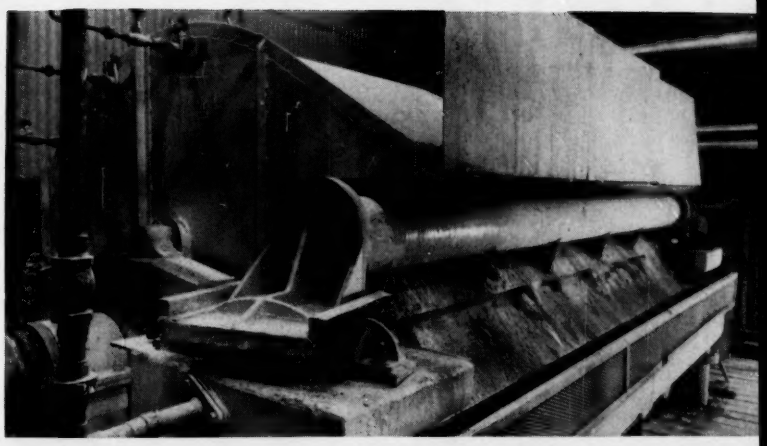
After the batch has solidified, a front-end-loader truck is driven over it to break the alum into chunks. These, in turn, are crushed into fist-size pieces by a single-roll crusher. Crusher product is elevated to a 12¾-ft.-dia., 24-ft.-high steel bin, where it is aged for 24 hr. Purpose of this aging is to change the alum's crystal structure so that it can subsequently be ground more easily.

After the aging period, the alum is sent to a diverter gate that either forwards the material to a screen for removal of lumps, or sends it directly to a cage mill. Mill output is screened to separate the several grades of ground product. Automatic bagging completes the processing.

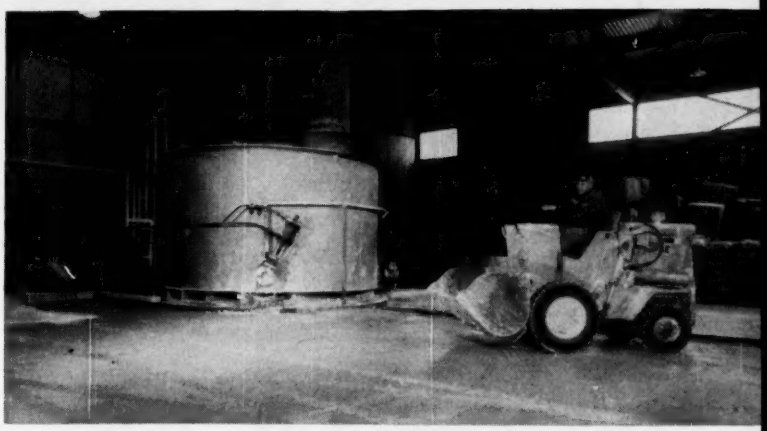
Plant air pollution is minimized—and housekeeping improved—by dust-collection systems that scrub air from both the bauxite-grinding and solid-alum-handling operations.

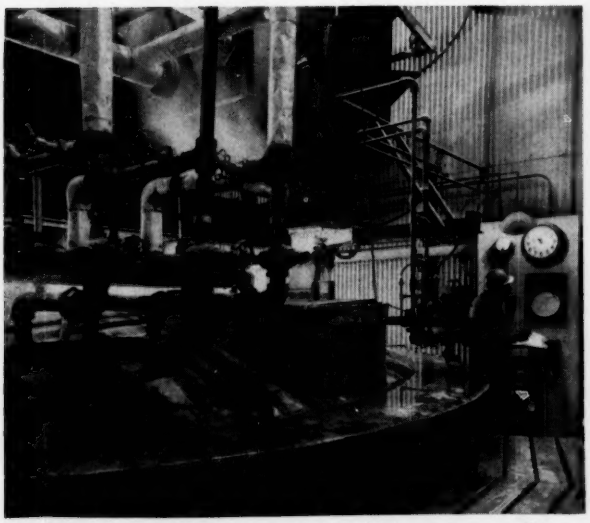


Rotary filter yields clear alum liquor for direct sales or production of solid grades. This represents the only point in the process where byproduct mud is discarded.



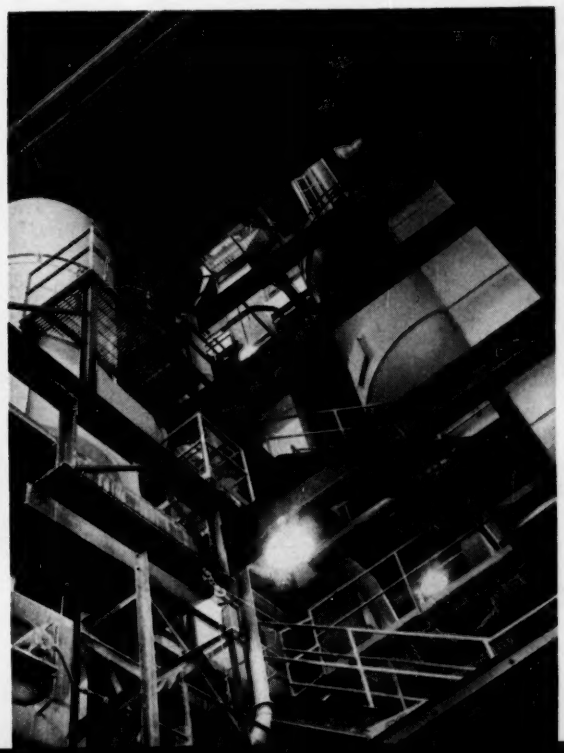
Evaporator, rear, concentrates clear product from rotary filter as first step in making solid grades from alum liquor. Concentrate is solidified on cooling "pan," such as one in foreground. Then, a front-end-loader truck cracks the solid sheet by driving over it and transports resulting chunks to a conveyor.



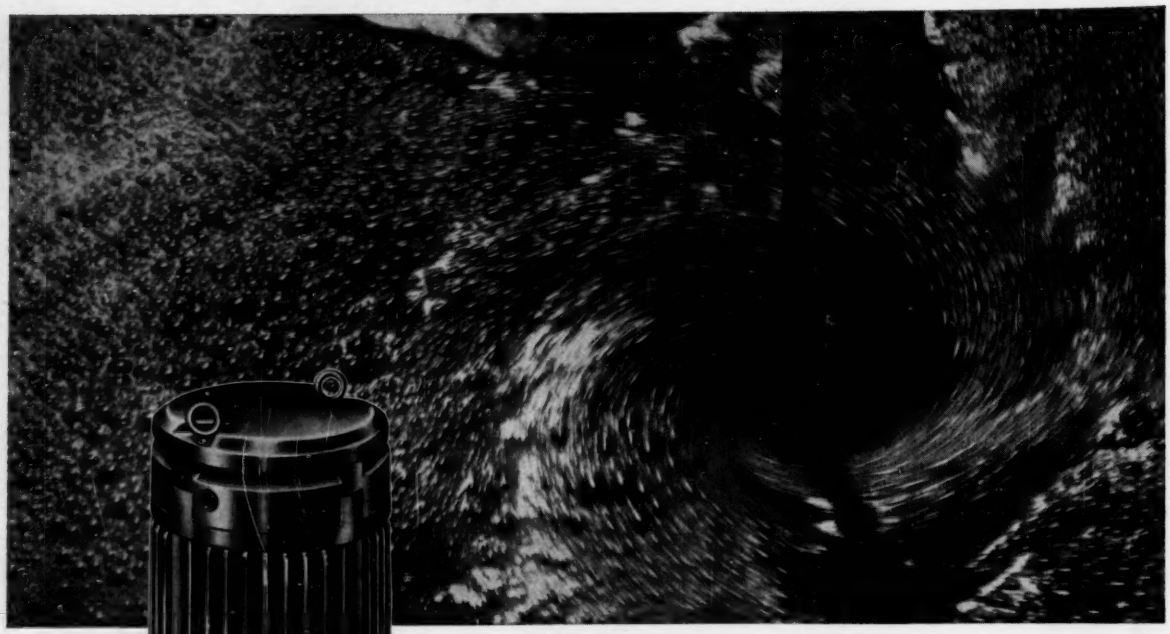


Digester, above, is the heart of the plant. It houses the basic, alum-producing reaction of bauxite and sulfuric acid.

Finishing facilities, right, convert fist-size pieces of solid alum into salable grades, which are bagged automatically.



HERE'S WHY PHILADELPHIA MIXERS LAST LONGER . . . COST LESS TO MAINTAIN!



1 **HIGH CAPACITY BEARINGS.** Extra heavy shafting is matched by extra large, high capacity bearings selected and sized to guarantee longest life and precision necessary for accurate shaft operation . . . least shaft deflection at the agitator shaft seal.

2 **HEAVY DUTY SHAFTING.** Philadelphia mixers are designed with stiffer, heavier duty shafting . . . giving you the advantage of the superior performance characteristics of solid output shaft drives designed specifically for mixer service.

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4 **COMPLETELY DEPENDABLE DRY WELL CONSTRUCTION** positively prevents oil leakage down the output shaft.

The complete line of Philadelphia mixers include vertical motor units like the one shown; horizontal motor, low headroom units; plus specially engineered units with variable speed drives or with impeller raising and lowering devices.

Our complete technical service organization is ready to work with you, whatever your requirements. Standard vertical and horizontal models to 250 HP. Special units to 500 HP. Mechanical seal or stuffed packing box. Paddle or turbine type impellers. For complete data write for catalog A-19.

philadelphia mixers

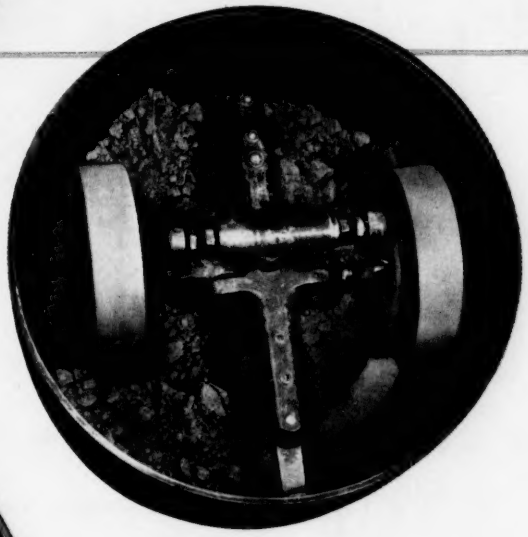
PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania

MIX-MULLER®

cuts waste with Controlled Dispersion

If you mix dry solids, how long has it been since you gave serious thought to the *action* employed by your mixer?



If you're mixing dissimilar and/or disproportionate materials; coating a fine dry material; blending liquids into powder or dispersing a small amount of liquid or binder—you need *more* than a simple stirring, tumbling or agitator action can *give.*

Look at it this way . . . today's raw materials are more uniform, of higher purity and they *cost* more. Quality control standards are stringent. It's easy to get caught in the bind between soaring materials costs, tougher control standards and high *waste.* Oddly enough, processors who spare no expense in otherwise equipping a process with the most modern time-saving components often overlook a principal source of waste . . . *outdated mixing practices.*

We would like to demonstrate
how you can save valuable raw materials and in many cases eliminate secondary processing by making the most of mixing properties—with a Simpson Mix-Muller. Write for details on a confidential, laboratory conducted mulling survey and for our Handbook on Mulling.

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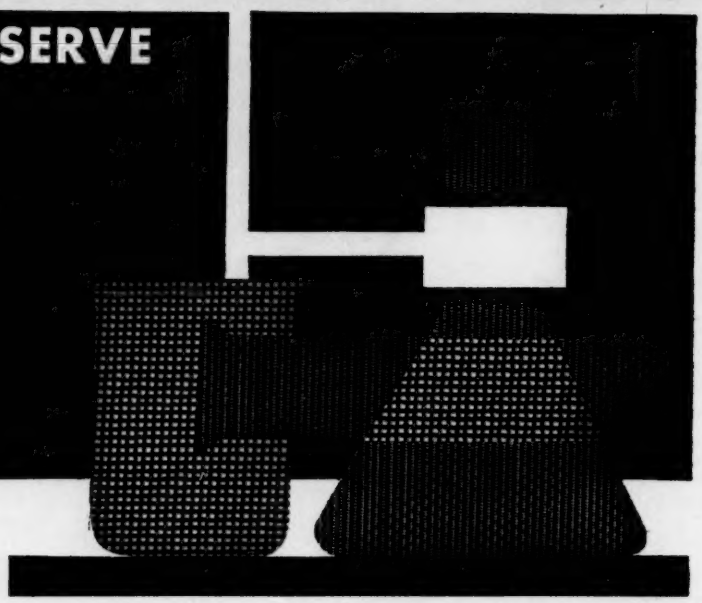
use wire cloth in critical operations?

THEN THEY DESERVE *Cambridge* WIRE CLOTH QUALITY & SERVICE



What is Cambridge Quality?

Wire that consistently meets metal or alloy analyses. Trained operators and modern looms to produce cloth from any metal or alloy in any weave. Constant inspection to assure high accuracy in mesh count and mesh size. Craftsmen to make fabrications in any size, shape or quantity to exacting specifications.

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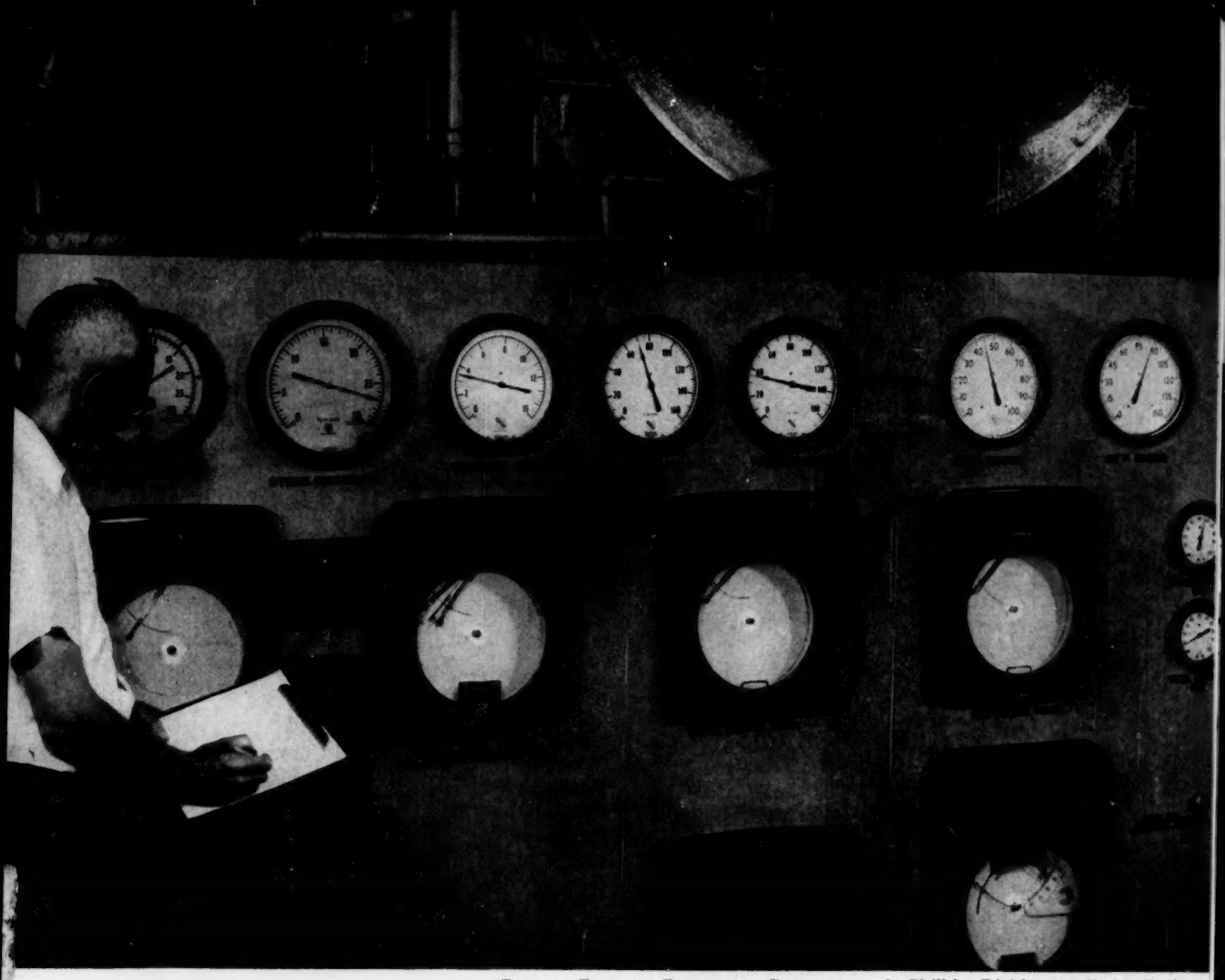

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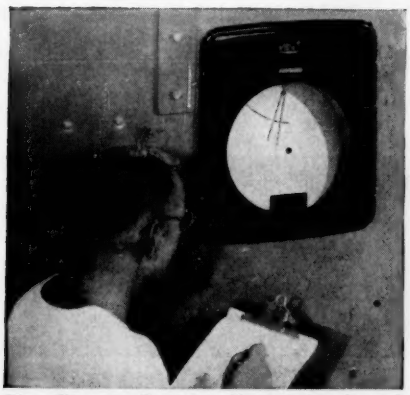

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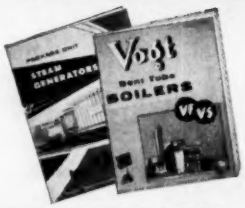

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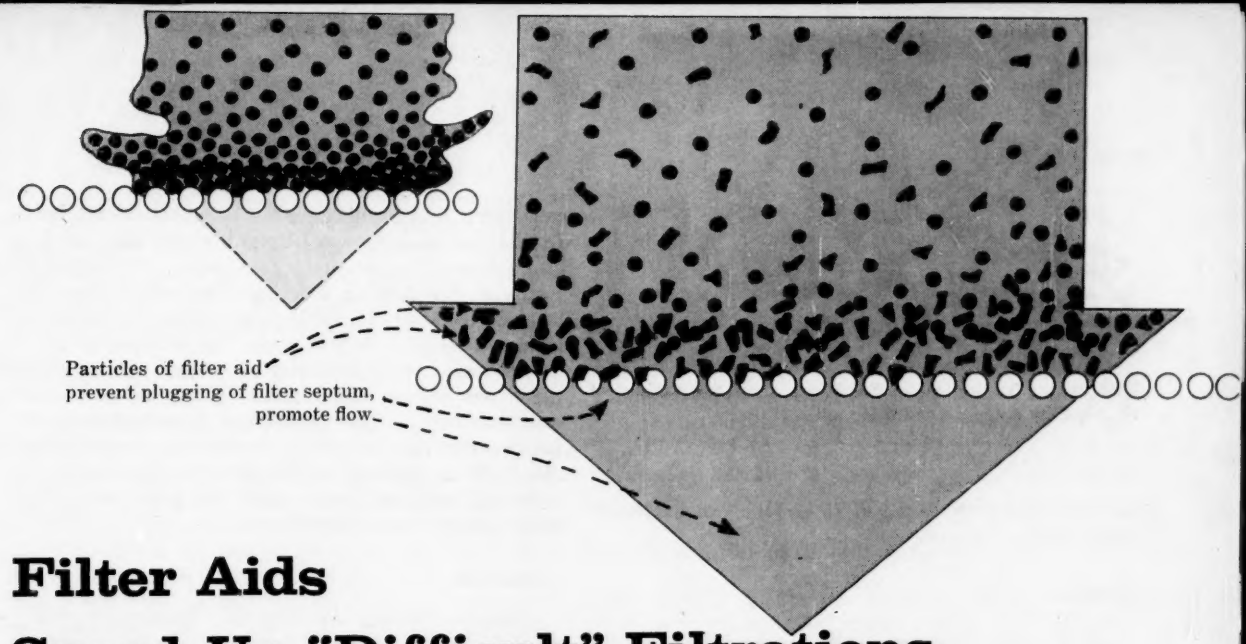


Filter Aids Speed Up "Difficult" Filtrations

Here's the background you need for selecting the proper type and grade of filter aid to clarify those hard-to-filter liquids.

THOMAS M. JACKSON, JR.
Celite Div., Johns-Manville Products Corp.

Clarification of liquids is of vital importance to many engineers in the chemical and process industries. Turbidity in these liquids is often made up of very fine gelatinous particles that are extremely difficult to remove by conventional filtration techniques. Clarification problems of this sort can be solved by the proper use of filter aids, and their use in industry is widespread.

From the production of basic chemicals such as sulfuric acid, caustic and soda ash, to the more glamorous products of the chemical industry such as antibiotics, low-pressure polyethylene and nuclear fuels, filter-aid filtrations play a vital part.

In general, the suspended solids in a liquid to be clarified are small and highly compressible. A filter septum with openings fine enough to hold back the suspended solids quickly becomes plugged or slimed over with the accumulation of solids removed and filtrate flow stops. Before a new cycle can begin, the septum must be cleaned—a most difficult job if its pores have become clogged with a collection of slimy solids.

Ideally, a filter aid will form an extremely fine filter surface, which will retain all solids. It will prevent contact between the solids and the filter septum and will extend the cycle length many times. Note that we are defining a filter aid as a material that performs its prime functions physically or mechanically; no adsorption or chemical action is involved.

To perform these three prime functions, filter aid particles should be:

- Inert. They must not affect the chemical makeup of the liquid.
- Insoluble. If the filter aid dissolves, it obviously cannot perform its functions.
- Incompressible. The filter aid cake must be able to maintain high permeability under the pressure differentials developed in the filter.
- Irregularly shaped, porous and small. These factors cause the cake to have high permeability, low resistance to flow, and many tiny flow channels that are small enough to screen out solids but numerous enough to provide maximum flow.

Filter aids are generally classified on the basis of their flow rate in a standardized test filtration, most commonly of a raw sugar liquor.[1] They are further classified as to how well they clarify the test liquor. Generally, the low flow-rate (finest size) grades give the best clarification, while fast flow-rate (coarsest size) grades give the poorest. A filter aid must be judged both on the flow rate it produces and the degree of clarity achieved in the filtrate.

With this background of ideal properties and bases for judging quality, let's see how the several commercially available filter aids stack up.

Diatomite

Diatomite (diatomaceous earth, diatomaceous silica, kieselguhr, etc.) is by a great margin the most important filter aid. Processed from deposits of fossilized diatoms,[2,3] it more nearly meets the criteria for the ideal filter aid than does any other. Many of its tiny particles are porous. All are highly irregular in shape and form a rigid, incompressible cake over the normal range of operating pressures. Since diatomite is primarily silica, it is relatively inert and insoluble. It can

Diatomite particles, magnified 500×, show the variety of shapes that make a good filter aid.—(Fig. 1)

be processed and classified to provide an extremely wide range of grades.

Perlite

Perlite filter aids are made by expanding perlitic rock, then milling and classifying the expanded product. Perlite, being primarily aluminum silicate, is inert and insoluble to about the same extent as diatomite. Its individual particles are irregular in shape, though not so varied as diatomite. Unlike diatomite, none of them are porous. A perlite filter cake is compressible at the upper range of normal operating pressures. Perlite filter aids are available only in the middle to upper-middle range of diatomite grades.

Owing to the basic difference in particle structure, perlite grades do not produce as high a degree of clarification in the standard sugar test as do diatomite filter aids of the same flow rate. Perlite forms filter cakes with densities from 20-30% lower than comparable diatomite grades. This lower density means that a lesser weight of perlite filter aid is required to build a filter cake of the same thickness. When other requirements of the filtration can be met satisfactorily, the lower density is advantageous.

Cellulose

Cellulose pulp has been used for many years in so-called pulp filters, which are not being considered here. In the last decade, specially processed cellulose has found increasing use as a filter aid. This material forms a free-flowing cake, but generally does not produce as good clarification as diatomite or perlite grades of comparable flow rates. The cellulose particles do not have a wide diversity of shapes, and the filter cakes are highly compressible. Since cellulose filter aids cost two to four times more than diatomite and perlite, they are advantageous only in special filtrations. Their use may be indicated in filtration of liquids that tend to dissolve silica, or when even slight silica pickup cannot be tolerated.

Asbestos

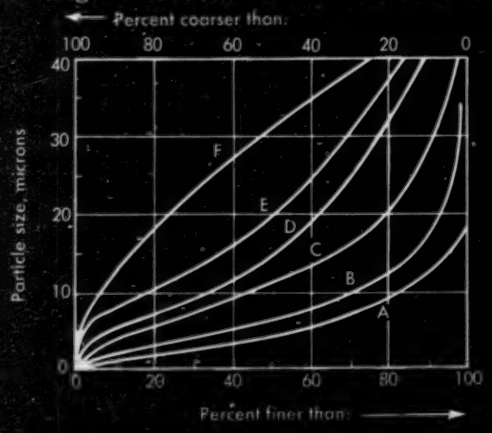
Asbestos fibers, like cellulose, have been widely used for years in pulp filters but have more recently found application as filter aids. These fibers are also highly compressible and form a paperlike cake. Although inorganic, and thus noncombustible, asbestos also has specific adsorptive properties that are beneficial in certain filtrations.

The price structure of commercially available asbestos fiber filter aids is such that their use can be considered only where their special properties are of distinct benefit. Compared with diatomite, for instance filtration-grade asbestos prices range from 10 times as high for the lower-quality grades, to over 30 times as high for special-purpose products.

Carbon

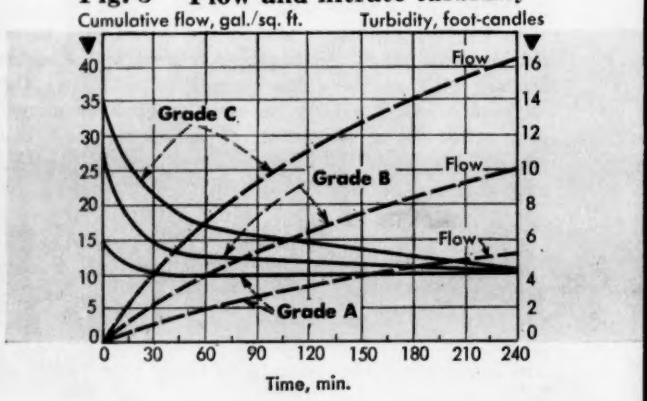
Carbon filter aids have been commercially available only in the last decade. We are referring only to non-activated carbons sold as filter aids, as defined in this article, not those whose primary use is for decolorization or adsorption of soluble contaminants. The individual particles are porous and irregular in shape, but they form cakes of heavier density and with lower clarifying capacity than diatomite.

Fig. 2 – Diatomite size distributions



Effects of filter aids demonstrated

Fig. 3 – Flow and filtrate turbidity



Because of this, and the fact that their prices are in the range of 1½-2 times as high as comparable diatomite grades, carbon filter aids, like cellulose and asbestos, are restricted to specialty applications where silica solubility may be a problem, or where the cake must be incinerated with a minimum of ash content.

Mixtures

It should seem likely that diatomite, because of its inherent good qualities as a filter aid, its wide range of grades, and its comparatively low price, should be the most widely used filter aid. It is. Perlite, with its density advantage, is second in importance. The other materials mentioned have certain properties that make them useful and worth the money in specific applications. Naturally, filter aid producers and users have combined the higher-priced specialty materials with diatomite to provide lower-priced filter aids with some of the desired special properties.

As stated, asbestos filter aids have the property of forming paperlike cakes that can be peeled off the filter septum. Such cakes are mechanically stronger and less susceptible to filter aid "bleed-through" resulting from pressure fluctuations. Mixtures of diatomite and asbestos tend to combine the desirable properties of each. Since less than 10% asbestos is commonly used to obtain the desired paperlike cake, prices of the blended products are in the range of 2-5 times those of comparable diatomite grades.

As in the case of asbestos-diatomite mixtures, a blend of asbestos and cellulose provides a combination of the properties of both, for those who prefer an all-fiber filter aid. Blends are commercially available with from 10 to 90% asbestos. The cellulose improves the flow rate of the mixture with corresponding sacrifice of clarification and, of course, at a price proportional to the relative quantities of the two components; the higher the asbestos content, the higher the price. A 50/50 blend of asbestos and diatomite made with non-acid-washed asbestos, sells for approximately 10 times the price of medium-grade diatomite alone.

Applications

There are many different types and designs of filters used in the process industries. Filter aids can be used on any filter—batch, semicontinuous or continuous—designed so that a cake can build up and then be removed. The types of filters and their applicability to various process requirements have been the subject of many articles and texts in the chemical engineering literature[4, 5] and will not be discussed in detail.

Batch Filtration With Filter Aids

The typical application of filter aid on a batch filtration involves three steps: precoating, filtration with body feed, and cleaning.

Precoating—The septum is precoated by suspending the proper grade of filter aid in clear liquid in a precoat tank and recirculating the slurry through the filter and back into the tank. The quantity of precoat varies from 3 to 12 lb./100 sq. ft. of filter area, depending on the filter design, type of septum and variety of filter selected. The liquid used for this operation should be well clarified, compatible with the liquid to be filtered, and have very nearly the same pH, viscosity and specific gravity. The most desirable precoating liquid is a portion of the filtrate from the previous cycle. The precoating should preferably be done at the same temperature and flow rate at which the filtration itself will be conducted. Departures from these desired conditions are common due to process considerations, but they may be the cause of cracks, bleed-through, incomplete coverage and the like.

The most common difficulties in precoating result from uneven flow over the filtering surface. This causes uneven cake buildup. In an ideal situation, resistance to flow would be the same over the whole

in filtration of raw sugar liquors

Fig. 4—Effect of body feed on flow

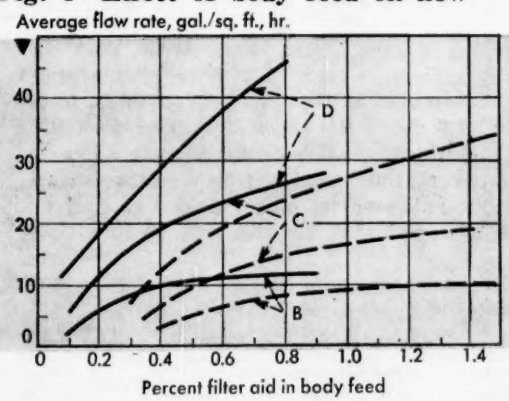
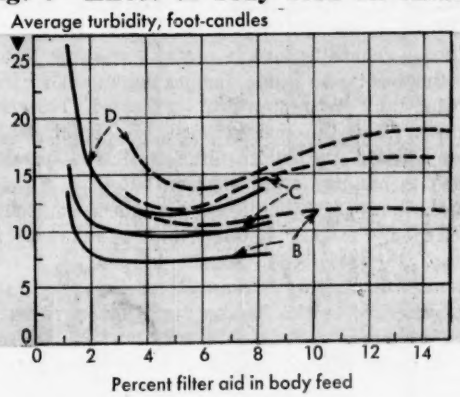


Fig. 5—Effect of body feed on turbidity



area of the filter septum, which would result in equal flow through each part of the available area and thus produce even cake buildup. This ideal is never attained in a plant-scale filter. However, in well-designed filters, the variations are minor and a filter aid precoat will equalize flow resistance so that, when filtration begins, an even cake is formed over the whole area. This is true even though the precoat itself will be slightly thicker at points of initial low resistance.

Serious problems arise in filters having wide variations in initial resistance over the filter area. For example, if a bottom-outlet filter is not full before flow starts, the cake forms only on the lower portions of the septum that are submerged. Proper venting is mandatory. Automatic vents, or a continuous bleed through a manual vent, can overcome operator forgetfulness. On a bottom-outlet filter, a gooseneck, rising well above the maximum liquid level in the filter, will prevent flow until the filter is full. Plate-and-frame filters are rarely provided with vents on each frame, and must be "force vented" by restricting the outlet until the filter is full. This problem is most troublesome in bottom- or side-outlet plate-and-frame filters.

Wide variations in the flow pattern can also result from dirty or plugged septums, or from clogged internal passages in the filter, downstream of the filter septum. These problems are progressive; once a septum starts to get dirty, or the filtrate "get-away" starts to clog up, the problem gets worse with each succeeding cycle.

A non-uniform precoat may also be caused by an incorrect flow rate during precoating. Too low a flow rate will result in gravity segregation of the filter aid particles; in the extreme case, the filter aid will end up on the bottom of the filter tank. More commonly, the precoat is classified with the fine particles at the top of the septum and the coarse particles at the bottom, causing preferential flow through the bottom.

Too high a flow rate can result in preferential buildup near the outlet, particularly in bottom-inlet, top-outlet filters. It also usually causes scouring of the filter septum near the inlet. Precoating at the same flow rate as the design rate of the filter is recommended.

Once the precoat has been applied, filtration can begin. Body feed of filter aid, completely mixed into the liquid, is usually required.

This is generally done in one of two ways. The first and simplest is to dump the proper quantity into an agitated tank of the liquid to be filtered. This is most common when the process liquor is batch-produced. In such cases, the entire filter station is usually designed to handle one production batch.

If the liquid to be filtered is produced continuously, usually only a small hold-up tank is provided ahead of the filter station to handle surges. A slurry of diatomite is made up in an agitated tank, and injected continuously into the line to the filter by means of a metering pump. A dry feeder may also be used to feed into an agitated hold-up tank at a controlled rate.

Selection of Filter Aid Grade

The major property differentiating the grades of a filter aid is particle size distribution. This distribution controls the flow rate and clarifying capacity of the various grades. The average particle size distributions of several grades are shown on Fig. 2. In the standard sugar test referred to earlier, the medium grade (*C*) will have a flow rate about six times that of the fine grade (*A*), and the coarse grade (*F*) about 20 times that of *A*. Of course, clarifying capacity is best with the finest grades and poorest with the coarsest.

How, then, is a filter grade selected for a specific filtration problem? Very simply, the proper grade is the one that will give acceptable filtrate at the highest flow rate.

The turbidity, or suspended solids content, of most industrial liquids is made up of particles having a wide range of sizes. In most cases, this means that although the coarsest filter aid will remove some of the suspended solids, even the finest will not remove them all. Thus, it is rarely possible to select a grade that will result in a 100% optically clear filtrate. Fortunately, it is likewise rare that such clarity is necessary or even desirable.

The lowest filtrate turbidity can be obtained only at the lowest flow rate and shortest cycle length. Conversely, maximum flow rates and long cycles can usually be obtained only by accepting higher turbidity (or lower clarity).

Fig. 3 shows the results of filtering a typical industrial liquid under standard conditions with three different diatomite filter aids (grades *B*, *C*, and *D* on Fig. 2). Note that *B*, the finest grade, has the lowest flow rate and the lowest turbidity.* Thus, the engineer must make a compromise between high-quality filtrate and low cost of operation, depending on his requirements.

As shown in Fig. 3, filtrate turbidity decreases during the cycle. The suspended solids removed in the filtration tend to "tighten" the cake by partial plugging of the flow channels through the diatomite. In filtrations where clarity is critical, the average turbidity over the whole cycle can frequently be reduced by recycling during the first 15-30 min. of the cycle.

Filter Aid in Body Feed

Except for selection of the proper grade, the most important variable in controlling filter aid performance is the amount of filter aid used in body feed. Figs. 4 and 5 shows the effect of varying filter aid dosage on turbidity and flow rate for two different lots of a typical liquid. Note that in the range shown the more filter aid used, the higher the flow rate. However, the average filtrate turbidity may go through a minimum.

This discussion has been confined to diatomite, but

* Turbidity is determined by measuring light reflected from suspended particles. As turbidity decreases, reflected light (shown in foot-candles) also decreases.

other filter aids have similar differences among the grades available.

Continuous Filters

For the sake of simplicity, only the rotary drum precoat filter will be discussed; this is the one with which filter aid is most commonly used. As in the case of batch filters, the complete cycle consists of precoating, filtration and cleaning; but the first two in particular are performed quite differently.

Precoating—The filter is precoated by recirculating a slurry of filter aid in clear liquid until the cake is 2-3 in. thick. The cake on a rotary is built up in a succession of non-uniform layers rather than formed relatively homogeneously, as in batch filters. Because of these two factors, the precoat is susceptible to cracking and chipping. Thus, it is very important that the liquid chosen for precoating rotary filters have as nearly as possible the same characteristics as the liquid to be filtered.

To prevent cracking and shrinking, the precoat should be applied so as to form a cake of the maximum possible density. Cracks permit unfiltered liquor to reach the filter septum, causing plugging and cloudy filtrate until the crack seals up again. Severe cracking can result in whole sections of the cake falling off the drum.

To achieve maximum density, the cake should be built up with as many thin layers as possible. This is

The kinds of filter aids to use; the places to use them—Table I

Liquid Filtered	Type Filter Used	Type Filter Aid Used: Diatomite	Perlite	Cellulose	Asbestos	Carbon	Mixtures	Grade Used: Fine	Medium	Coarse
Cane sugar liquors	Pressure leaf	●	●				●	●	●	
	Plate and frame	●	●					●	●	
Beet sugar liquors	Plate and frame	●	●						●	
	Pressure leaf	●	●				●		●	
Corn sugar	Plate and frame	●							●	
	Pressure leaf	●	●						●	
	Rotary precoat	●	●						●	
Caustic soda	Plate and frame	●		●		●			●	
	Pressure leaf	●		●		●	●		●	
Electrolytic brine	Pressure leaf	●	●	●		●			●	
Uranium leach liquors	Pressure leaf	●	●				●		●	
	Plate and frame	●	●						●	
	Rotary precoat	●	●						●	
Beer — prefiltration	Pressure leaf	●	●						●	
polish	Pressure leaf	●			●		●	●		
	Horizontal plate	●			●		●	●		
	Plate and frame	●			●		●	●		
wort	Pressure leaf	●	●							●
Wine	Plate and frame	●		●	●		●	●	●	
	Pressure leaf	●		●	●		●	●	●	
Gelatin	Pressure leaf	●			●		●	●	●	
	Plate and frame	●			●		●	●	●	
Water	Pressure leaf	●	●	●			●		●	●
	Rotary precoat	●	●						●	
Synthetic resins	Plate and frame	●	●						●	●
	Pressure leaf	●	●				●		●	●
	Horizontal plate	●	●						●	●
Molten sulfur	Plate and frame	●	●	●		●			●	●
	Pressure leaf	●	●	●		●			●	●
Antibiotic fermentation broth	Rotary precoat	●	●				●		●	
	Plate and frame	●	●				●		●	
	Pressure leaf	●	●				●		●	
Varnish	Plate and frame	●	●				●		●	●
	Horizontal plate	●	●						●	●
	Pressure leaf	●	●						●	●
Solvents	Pressure leaf	●	●				●		●	●
Fats & oils	Plate and frame	●	●		●			●	●	
	Pressure leaf	●	●		●		●	●	●	
	Horizontal plate	●	●					●	●	
Lube oil additives	Plate and frame	●	●					●	●	
	Pressure leaf	●	●				●	●	●	
	Rotary precoat	●	●					●	●	
Pectin	Plate and frame	●						●	●	
	Pressure leaf	●					●	●	●	
Glycerine	Plate and frame	●							●	
	Pressure leaf	●							●	
Gums & adhesives	Plate and frame	●	●						●	●
	Pressure leaf	●	●						●	●
Titanyl sulfate (leach liquor)	Pressure leaf	●					●		●	
	Rotary precoat	●							●	

done by precoating with thin slurries (3-4%) at maximum drum speed, starting at low differential pressure and then gradually building up until, at the end of precoating, the pressure is as high as it will be when filtration starts.

Also, dense cakes result from the use of high or low pH slurries, rather than near-neutral. Filter aids have a tendency to flocculate in relatively pure liquids and form flocculated cakes. It is vital not to use neutral slurries for precoating if the liquid to be filtered has a high or low pH, to prevent the possibility of severe cracking owing to deflocculation of the formed cake.

The use of some fibrous filter aids in conjunction with diatomite or perlite as the prime filter aid has become rather common in rotary precoat applications. The fibers give some tensile strength to the cake and reduce the danger of cracking.

Filtration—After the precoat is in place, the liquid to be filtered is turned into the bowl and filtration begins. The knife (doctor blade) is advanced manually to begin shaving the cake, and the automatic knife advance started.

The rate of advance selected is determined by the degree of penetration of solids into the face of the precoat cake. If there were no penetration, the rate of knife advance would be zero. In a few cases, actual penetration approaches this, and the knife is left in the same place for hours at a time. Cycles several weeks long are not uncommon.

However, in most industrial applications, solids penetrate, fill the voids in the cake, and result in a reduced flow rate. Rate of knife advance is most commonly set at about the rate of penetration. Thus, if penetration is too high, the rate of knife advance must be high, resulting in short cycles and high filter aid usage.

Grades for Rotary Filters

Selection of the proper grade for a rotary precoat filtration is based on the same considerations as for pressure filtrations; select the aid that produces acceptable clarity at highest flow rate. However, there are additional factors to consider.

In the first place, the filtration rate is usually controlled by the cake of solids filtered out on the surface of the precoat. Thus, the filter aid selected must form a precoat with permeability equal to, or greater than, that of the filtered solids. A coarse filter aid will demonstrate no advantage over a less-expensive finer grade that, however, has adequate permeability to provide proper filtrate "get away."

Secondly, if penetration is not effectively prevented, it can drastically reduce the permeability of the precoat. Thus, the grade selected must control penetration. Although, in batch pressure filtration, a coarser filter aid will produce a faster flow rate, it may not do so on a rotary precoat filter. In fact, selection of a finer grade of filter aid has often resulted in faster flow rates because of reduced penetration.

Normally, body feed is not used in a rotary precoat filtration. However, body feed will increase the permeability of extremely difficult-to-filter liquids, and will reduce penetration. Use of the finest grades is recommended for body feed. The filtered solids usually form a very thin cake, and the relatively low permeability of the fine grades is not significant. On the other hand, the much larger number of particles present in the filter aid surround the slimy particles in the liquid to be filtered, and reduce penetration more effectively than the coarser grades. Since penetration is usually the cause of low flow rates, body feed can be a practical solution to this problem.

It's Still an "Art"!

The technology of filtered-aid filtration, or even filtration in general, is not so highly advanced as most other unit operations in chemical engineering. The average engineer faced with a specific problem in filter aid filtration, can often obtain considerable aid from suppliers of filters and filter aids. The empirical data in their files, obtained from actual filter operations, can be most helpful in the solution of new problems.

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Meet the Author

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A native of Philadelphia, he received the degree of Bachelor of Chemical Engineering from Cornell University. Mr. Jackson is former chairman of the New York section of AIChE and a member of the American Water Works Assn. He is also president of the Northeast Swimming Pool Assn. and has been chairman of the Committee on Diatomite Filter Standards for the National Swimming Pool Institute.

During World War II, he served with the U. S. Navy.

Troubleshooting New Equipment

What do you do when your stills start to foam over, your filter cake cracks, your jet pumps won't pull their rated vacuum and your heat exchangers or instruments cease to function? Here's help with that classical bugaboo, the inate perversity of inanimate objects.

J. E. TROYAN, *Olin Mathieson Chemical Corp.*

(The three articles in this series supplement the author's 20-page CE Report on plant startup, which appeared on pages 107 to 126 of our Sept. 5, 1960 issue. Part I, pp. 223-6, Nov. 14, 1960, dealt with general aspects of troubleshooting new processes. The present article takes up troubles with stills, heat exchangers, filters and instruments. Part III, in an early issue, will go into difficulties resulting from pumps, seals, compressors, valves and agitators.—*Editor.*)

Practically every piece of equipment employed in your new plant may give trouble if it is not properly installed, operated or maintained. Even when you take suitable care, there may be difficulties from shortcomings in design or from any number of imbalances in the process. Anticipating such possibilities, recognizing trouble symptoms and applying corrective action are responsibilities that engineers and supervisors should be prepared to assume during startup.

In considering equipment troubleshooting, I shall touch upon some of the more common unit operations as well as some specialized pieces of equipment that experience shows to be frequently vulnerable to startup difficulties. Books, technical articles and vendors' bulletins provide more comprehensive details on these and many other items. Seek out as much as possible of this background information on units you will be operating, so that you will be equipped to meet the challenge of equipment that does not perform as anticipated.

If you lack specific hints from vendors on problems that develop, analyze the situation carefully by applying both fundamentals and common sense in equal measure before making abrupt changes.

Now let us consider some specific unit operations and the ailments that may afflict them. We will begin with:

Distillation Difficulties

There can be many operating difficulties associated with distillation columns, particularly when they enter service for the first time. Such problems include flooding, entrainment and similar occurrences that interfere with proper fractionation. How can the operator recognize and correct these situations? Temperatures, pressures, and product purity are the diagnostic tools for the difficulties we shall describe.

You must have vapor pressure-temperature data on the materials being fractionated when you are operating distillation columns. Pressures (read on process gages) can serve as a temporary guide to performance when key temperature control is inoperable or not dependable. Grabbing samples from various trays for check analyses is another conventional technique for determining performance.

Operators should check the temperature profile across the column to be certain that it is consistent with the anticipated pattern. Excessively high temperatures in upper parts of the column may indicate vapor bypassing, due to excessive velocities or inadequate liquid tray-loading. Insufficient liquid on trays can be caused by inadequate weir height or excessive leakage around bubble-cap chimneys or tray gaskets.

Note that inconsistent temperatures may not always indicate process upsets. Checking thermocouples or seeing that thermowells are properly installed can sometimes eliminate what at first appears to be a process problem. Be certain that thermocouple immersion liquids are provided where required and see that insulation is sufficient to stop heat leaks around thermocouples or thermometer bulbs.

Column flooding is most frequently confirmed by differential pressure readings. When much higher than normal Δp's prevail, particularly with fluctuation or surging, it is very likely that there is flooding. Typical techniques for "dumping" flooded columns are: withdrawing or curtailing feed, dropping reboil heat, or temporarily increasing pressure.

Usual cause of flooding is excessive liquid downflow at high vapor loading. Plugged bubble caps, or holes in perforated trays, can also cause this condition. Too cold a feed can also result in flooding and poor column operation. Finally, don't overlook the possibility that the bottoms takeoff line from a still may be plugged, causing the liquid level to rise above the reboiler vapor inlet to the column.

Entrainment of liquid can be traced to excessive vapor velocities through bubble cap slots or the column proper. This can be reduced by cutting back reboil heat. Engineers should recheck liquid and vapor velocities to be certain that design considerations have not been overlooked. When physical characteristics of the materials involved make the problem chronic, you might have to install demisting or scrubbing equipment. Such devices are often additionally useful in preventing color in overhead products from entrainment of solids.

Foaming-over is another problem in distillation. This

50 tips on instrument troubleshooting

I. Recorders and Recorder-Controllers

Trouble (A): Pen dead at zero.
Cause: (1) Check isolating valves at process impulse line; see that equalizing valve is shut. (2) Look for plugged impulse line. (3) In cases of pneumatic transmitters, check air supply to transmitter. (4) Look for broken or loose lines: (5) Primary sensory device not installed (i.e., orifice plate, temperature bulb). (6) Be sure process step is actually in operation (pump running, etc.).

Trouble (B): Recorders with two or more pens record at the same point on the chart, but should be at different points.
Cause: (1) Pens may not pass owing to mechanical interference. (2) Make sure instrument leads are clear and properly connected.

Trouble (C): Chart not moving.
Cause: (1) Chart loose on hub. (2) Chart loose on chart rewind roll. (3) Clock not running; power not on drive.

Trouble (D): Chart readings apparently not correct or not consistent with local gages.
Cause: (1) In case of chemical seal attachments, sealing fluid may have leaked out or there may be hole in diaphragm seal. (2) Trouble in gage movements. (3) Gage may not have been read properly. (4) If dual-pointer instrument, be sure to read right pointer. (5) Check agreement of chart with transmitter range. (6) Check agreement of output pressure from transmitter with pen.

II. Manometers

Trouble: Manometer does not indicate when equipment is in service.
Cause: (1) If manometer has sealing fluid, make sure it is the proper type fluid, and that the manometer is properly filled. (This is an instrument technician's job). (2) Check all valves and valve arrangements to be sure they are properly set.

III. Control Valves

Trouble (A): Valves do not respond to air change.
Cause: (1) If valve has a valve positioner, check its air supply. (2) Check for broken air lines. (3) Check any interlocks on the control loop. (4) Valve action may be reversed.

Trouble (B): Valve changes position, but brings about no change in process flow.
Cause: (1) Valve may be plugged. (2) Block valves in process line may be closed. (3) Valve plug may have broken off from the valve stem. (4) Valve action may not be correct for application.

is ascribed primarily to properties of the materials being handled under the turbulent conditions in the column. Column design (tray spacing) should consider this potential difficulty. Defoaming agents such as silicones have eliminated the problem in many cases; for example, in the recovery of styrene from synthetic rubber latex by steam stripping.

Packed columns are particularly vulnerable to certain of these operating difficulties. If packing is not properly loaded into the tower and provision made for even liquid distribution, poor separating efficiencies, if not flooding, may result. Anticipate such problems while designing and installing columns because correcting faults during startup is expensive.

Where low-boiling liquids are being distilled, there is possible danger that steam condensate will freeze in the reboilers, resulting in split steam tubes, if operating conditions should become seriously upset. If water and the process fluid are not compatible, you should specify a cascade heating system (e.g., steam to oil; oil to process).

Contamination and foreign bodies in the system can also affect distillation performance. An example is worth mentioning: during operation of a unit separating several hydrocarbons, we were getting inconsistent product quality. This variation appeared to be related to unusual variation in reflux flow, which could not at first be explained. The cause was eventually disclosed as a fluttering obstruction of tramp metal under the reflux control valve seat.

Vacuum distillations are particularly touchy, requiring careful operating control and tight systems. Minor air leaks may upset reflux flow, product takeoff or process conditions in general. Watch for bubbles in reflux rotameters or sight ports, and vacuum control difficulties, for evidence of a leak. Preliminary pressure testing should be thorough to obtain tight equipment. Proper pressure equalizing between column and receivers is essential for smooth takeoff. Do not overlook plugging of takeoff lines by process material or "dirt," especially if receiver flooding has occurred. Water in the product from vacuum stills equipped with steam jets is frequently evidence of jet malfunctioning (assuming the condenser or reboiler tubes are tight).

Here are a few pointers to improve steam-jet operation:

- Wet steam or low steam pressures cause "kickback" on jets. Watch for faulty insulation of steam lines and see that dry or slightly superheated steam is supplied at the design pressure.
- If jet nozzles should plug with scale, or diffusers plug with process dirt, performance will be poor until the units are cleaned. A test manometer or gage at the jets is essential for finding the cause of poor vacuum. Isolate jets from the process to see if the design vacuum can be pulled. If it can, the problem is with the column or piping; if not, check the condition of jet internals. Look for deposits or for signs of wear due to corrosion or erosion.
- Be sure that multistage condensing jets are get-

IV. Level Controllers
General Suggestions: (1) If level controller has pneumatic transmitter, look for isolated or broken lines or leaks. (2) Excessive pressure during pressure test can collapse floats and wreck level-measuring device if unit is not suitably protected.

V. Rotameters
Trouble: Rotameter shows no indication of flow.
Cause: (1) Check valving arrangement to be sure all valves are in proper position. (2) Be sure material being measured is being delivered to rotameter. (3) Check whether float is stuck with dirt or foreign matter. (4) Be sure that meter has proper tube and float installed. (5) In case of pneumatic transmitter, check air supply, loose or broken lines.

VI. Purge-Fluid Units
Trouble: No indication of flow.
Cause: (1) Purge meter may be valved off. (2) Supply of fluid to purge meter may have been turned off. (3) Look for broken or loose lines from purge source. (4) Impulse lines may be plugged with process solids.

VII. Weighing Scales
General Suggestions: (1) Once set, scales should never be moved or left exposed to contamination. Scale heads should be locked out when scale is not being used. (2) Check-weights can be used by Operations for spot checks on scales, but all repairs and adjustments should be sole responsibility of scale manufacturer or instrument department.

VIII. Electronic Recorders
Trouble (A): Analyzers (inoperable or questionable readings).
Cause: (1) Power off or fuse blown. (2) No sample flow. (3) Sampling lines plugged. (4) Sampling streams contaminated; do a better purge job. (5) Pressure excessive in sample cell.
Trouble (B): Temperature recorders (inoperable or questionable readings).
Cause: (1) Power off or fuse blown. Check battery. (2) Loose connection on thermocouple terminal strip. (3) Read indicator scale plate; dimension of chart paper may be affected by humidity.

ting the proper amount of cooling water. If insufficient, the condenser and tail pipe will be hot; if the jets are flooding, vacuum will fluctuate. Feel the jet diffuser to be sure that the temperature is holding steady.

• Do not try to establish operation at a higher vacuum than the vapor pressure of the liquid in the system.

Heat Transfer Troubles

A prevalent difficulty with heat transfer equipment is fouling by process materials following upsets during startup. Operators should note temperatures in and out of the coolant or heating medium and the process stream itself. Trends or abrupt changes in normal temperature spreads may indicate tube fouling. Pressure drop across the tubes is another indicator of plugging or fouling, but it is not apt to reveal the problem until serious plugging of the parallel tubes in a bundle has resulted.

If a heater is failing to supply the design heat flux, and fouling is not involved, you can check two other points. Where steam is the heating medium, the condensate trap may be inoperable and water may then back into the reboiler or heater. When steam is at the proper supply pressure and temperature, but there is still no heat transfer, chances are that the unit is vapor bound as a result of insufficient, or even no, liquid flow through the tubes. Check the feed pump output and the possibility of plugging of piping or tubes. In the case of a still with a thermosiphon reboiler, flooding of the column bottom can cover the vapor outlet of the reboiler causing poor performance.

Where frequent plugging occurs or is anticipated in a process, provide a spare tube bundle. You can then switch bundles quickly, permitting cleaning of the fouled unit without further production delay.

Leaks around head flanges or stuffing box assemblies are frequently encountered in heat exchangers that operate at elevated temperatures. When you find leaks, careful tightening under process conditions will assure tight joints. When leaks occur in tubes, plugging off the faulty tube with a steel plug or by use of welding will minimize shutdown time.

When leaks between the process side and the heating medium cannot be tolerated, use either double tubesheet construction or a cascade heat transfer system, but plan for it before you build the plant.

Filtration Failures

Initial filter performance in a new plant must be closely checked to see whether design bases are being followed. Occasionally, filtration properties of precipitates handled in the pilot plant may change when large-scale operations are attempted. Crystal sizes or particle size distribution may be different. If the desired separation is not being achieved, changes may be required in slurry concentrations, amounts of filter aid,

filtration temperatures or in processing conditions prevailing prior to the filter step.

Solids or cloudiness in the filtrate may indicate the presence of smaller particles than contemplated by the plant designer. Use of a filter aid will give temporary relief if the precipitate or solid phase is to be discarded. When the solid is being recovered, yield losses may have to be tolerated until either the crystallizing or precipitation conditions can be modified to eliminate the fine particles; or a finer filter medium (cloth or screen) can be provided.

Passage of solids through the filter may also occur if the cake cracks. On a rotary unit, this difficulty is generally easy to observe; in leaf filters or other enclosed systems, the problem cannot be as readily confirmed. It may be necessary to vary feed rates, slurry concentrations, filter pressures or vacuums, extent of precoat, distribution of feed (to the filter surface) or other variables peculiar to individual filtration equipment, until cracking is eliminated.

Remember that in leaf-type filters, once the cake is formed, pressure should be sustained by liquid or gas pressure to prevent cake cracking or slippage. If a process upset occurs and the filtrate turns cloudy, chances are that the cake has opened up or that precoat has been lost in some area of the filter. This may be corrected in some instances by adding more filter aid to the batch, then recycling until the filtrate is clear.

Keep an eye on pressure drop across the filter. If this becomes excessive before filtration is complete, it will not always be desirable to try to push the remainder through by higher pressures. Sometimes, the cake will become so compressed that no flow will be possible. Patience may permit completion of the job; urgency to move ahead may set you back seriously. If the cake space is fully occupied, because capacity has been exceeded, the cake must be dumped. More may be present than you figured. When a viscous solution is being handled, excessive pressure drop can be reduced by increasing temperature within limits permitted by the process.

In rotary filters, where cake washing may be involved, look again for cake cracking if poor filtrate removal is noted. Cracking here may be eliminated by changing the slurry concentration or method of feeding, or by using pressure rolls on the cake.

Instrument Ills

Instrumentation can and does contribute its share of problems during startup. Unless instruments are given special care when being checked out and put into service, process operations may be seriously handicapped. Even when systems are properly checked, frequent process problems result during startup from poor instrument performance.

During initial operation, plant personnel should become familiar with the characteristics of the instruments in the plant. Operators should learn to recognize the normal state of their instruments and check them by supplementary observations of physical conditions in the process. Comparing centralized recorder-controller instrument readings with spot observations will show whether all is well.

The operating man should neither trust nor distrust his instruments. When something appears to be out of line, take bearings from two directions. Do not draw conclusions without having confirming data. Watch trends in temperatures, pressures and flows, and thus be better prepared to recognize a true deviation in the process.

Instruments should be calibrated against standards if there are any questions. This is particularly important when instrumentation is vulnerable to straying—for example, in weigh scales, thermocouples affected by corrosion or short circuits—or where process upsets have otherwise disrupted instrument accuracy.

Automatic control valves are a common source of difficulty during startup. Unusual action of a valve may be caused by accumulation of dirt in the valve port. Wrong direction travel of valves should be corrected during the instrument checkout. If required flow cannot be handled by a control valve because it is too small, partially open the bypass around the valve and allow the valve temporarily to take over control on the remaining stream. Sometimes, valve stems will fall off because of faulty installation or manipulation.

Occasionally, valves will not operate properly if the packing has been pulled up very tight to prevent leakage during the pressure testing period. This will not only hamper valve operation but may ultimately damage the fine-finish stem.

In starting up a plant, it is normal practice to use manual controls until the flows and operating conditions are properly leveled out. Here again, there is often a tendency to attempt automatic control before it has been established that suitable operation of the process is possible. On the other hand, delaying the switch to automatic control has also caused its share of startup headaches. Close cooperation between the operating supervisor and instrument personnel should be maintained in switching from manual to automatic.

Some typical checks for instrument troubleshooting during startup are summarized in the accompanying table. Operating personnel can significantly reduce downtime caused by instrument problems, if they follow such a check list. The experienced operating man can often effect the required corrective action. In other cases, however, it is wiser to call on trained instrument personnel to diagnose the trouble and solve the problem.

Meet the Author

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Evaluate Heat Exchanger Coefficients

Where a heat exchanger is the limiting factor in the capacity of a process unit, a method that corrects measured heat-transfer coefficients to standard flow rates permits close monitoring of the coefficient to give the optimum cleaning cycle for any type of heat exchanger.

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Many problems confront the engineer in the correct evaluation of the actual over-all heat transfer coefficients in heat exchangers. There are, of course, the normal difficulties in the experimental determination of entrance and exit temperatures and flow rates of the fluids.

Another of the problems that must be solved is how to correct coefficients under the influence of varying fluid rates through the exchanger. Since the fluid rates influence the film coefficients, over-all coefficients evaluated at different fluid rates are not directly comparable. These must be corrected to standard flow rates for proper determination of the extent of fouling. Here is a method that allows over-all coefficients taken at varying fluid rates to be corrected to standard flow rates.

The capacity of a heat exchanger decreases with time because of fouling. Fouling may be due to dirt, tars, polymers, scale, corrosion or other sources that form a film of low conductivity on the heat transfer surface. Various means of reducing this loss of capacity are available.

When exchangers operate under such conditions that they become fouled and must be removed from service for cleaning, it is advisable to closely monitor their performance. Proper analysis of the operating data is necessary in order to judge the performance of the exchanger and to arrive at optimum cleaning cycles.

Consider Basic Equations

Over a limited temperature range in turbulent flow, the film coefficients for a given heat exchanger may be expressed by the general equation:

$$h = \phi (W^n) \qquad (1)$$

where W is the flow rate and n depends upon the physical arrangement of the exchanger. For the inside of the tubes, value of n may be taken as 0.8, and for shellside coefficients in shell-and-tube heat exchangers, n is 0.6. Eq. (1) is restricted to sensible heat transfer between Newtonian fluids in turbulent flow.

By setting a standard flow rate for a given exchanger, a factor for correcting film coefficients may be evaluated from the relation:

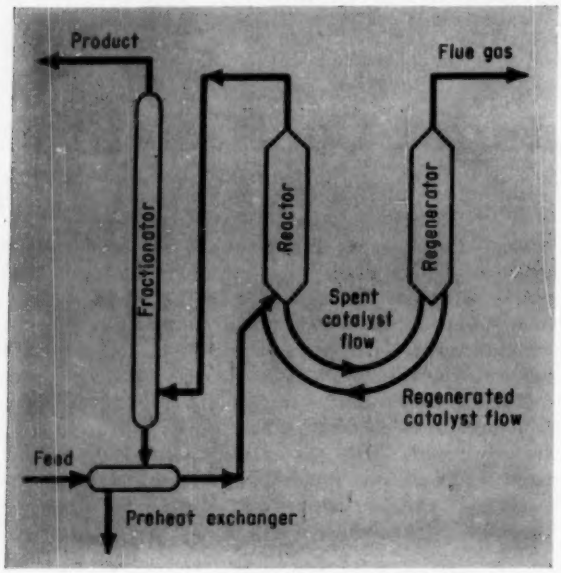
$$y = \left(\frac{\text{standard flow rate}}{\text{observed flow rate}} \right)^n \qquad (2)$$

Over-all coefficient for a heat exchanger depends upon two film coefficients, which are the resistance of the tube wall or other heat exchange surface and the fouling factor. In most cases, resistance of the tube wall may be neglected. For general use, however, this resistance has been retained in all equations so that in the few cases where it is important, it will not be omitted. The over-all coefficient is given by the expression:

$$\frac{1}{U} = \frac{1}{h_i} + \frac{1}{h_o} + \frac{x}{k} + f \qquad (3)$$

Remember that the two film coefficients, wall re-

Heat exchanger controls feed rate—Fig. 1



sistance and fouling factor, should be corrected to the same area basis on which the over-all coefficient is calculated.

To correct observed coefficients to standard flow rates, the observed coefficient must be multiplied by a correction factor:

$$U_{st} = U_{ob} \times F \tag{4}$$

Derive Working Relations

The observed coefficient is composed of the elements given by:

$$\frac{1}{U_{ob}} = \frac{1}{h_i} + \frac{1}{h_o} + \frac{1}{b} \tag{5}$$

where h_i and h_o are the actual film coefficients at the observed flow rates and $1/b$ is the total resistance of tube wall x/k plus the fouling factor f. The coefficient that would be obtained at standard flow rates is given by a similar expression:

$$\frac{1}{U_{st}} = \frac{1}{h_{is}} + \frac{1}{h_{os}} + \frac{1}{b} \tag{6}$$

where h_{is} and h_{os} are the film coefficients at standard flow rates.

To aid in the derivation of a correction factor, the following terms are defined. The symbol r denotes the ratio of the inside to the outside film coefficients at the standard flow rates.

$$r = h_{is}/h_{os} \tag{7}$$

The term a is defined as the ratio of the fouling resistance to the film resistance, multiplied by the quantity $(1 + r)$.

$$a = \left(\frac{1/b}{(1/h_{is}) + (1/h_{os})} \right) (1 + r) \tag{8}$$

The two film coefficients are related by the equation:

$$h_{is} = r h_{os} \tag{9}$$

where h_{is} and h_{os} are defined by:

$$h_{is} = y_i h_i \tag{10}$$

$$h_{os} = y_o h_o \tag{11}$$

From Eqs. (7), (10) and (11), we find:

$$h_i = r y_o h_o / y_i \tag{12}$$

From Eqs. (5) and (12):

$$\frac{1}{U_{ob}} = \frac{y_i}{r y_o h_o} + \frac{1}{h_o} + \frac{1}{b} \tag{13}$$

From Eqs. (6), (10), (11) and (12):

$$\frac{1}{U_{st}} = \frac{1}{r y_o h_o} + \frac{1}{y_o h_o} + \frac{1}{b} \tag{14}$$

From Eqs. (4), (13) and (14), we find:

$$\frac{1}{U_{st}} = \frac{1}{r y_o h_o} + \frac{1}{y_o h_o} + \frac{1}{b}$$

$$\frac{1}{U_{st}} = \frac{1}{F} \left[\frac{y_i}{r y_o h_o} + \frac{1}{h_o} + \frac{1}{b} \right]$$

then, equating and solving for F, we obtain:

$$F = \frac{b\,(y_i + r y_o) + r y_o h_o}{b\,(1 + r) + r y_o h_o} \tag{15}$$

Eq. (8) may be reduced to:

$$a = \left(\frac{1 + r}{b} \right) \left(\frac{h_{is} \times h_{os}}{h_{is} + h_{os}} \right)$$

Solving for the term b by using Eqs. (9), (10) and (11) gives:

$$b = r y_o h_o / a$$

Substituting this value of b into Eq. (15) yields:

$$F = \frac{a + r y_o + y_i}{a + 1 + r} \tag{17}$$

Thus, Eq. (17) is the resultant expression for calculating a correction factor for heat exchanger coefficients. For clean heat exchangers, the value of a is small and can usually be neglected. An exact solution can be obtained, however, by substituting the resistance of the pipe wall x/k for the term $1/b$ in Eq. (8).

How to Apply Correction Factor

Consider the fluid catalytic cracking unit shown in Fig. 1 as a typical unit where Eq. (17) might find use. A gas oil is fed through a feed preheat exchanger into the reactor. The cracked products go overhead through cyclones and into the main fractionator. The hot stream of slurry oil from the bottom of the fractionator is used to preheat the feed. The catalyst in the reactor is circulated to the regenerator where the carbon is burned off with air.

This particular hypothetical fluid unit is limited by the carbon burning capacity of the regenerator. The ability to burn off carbon is reflected in the amount of heat that can be transferred to the reactor by sensible heat in the catalyst. Thus, the charge rate to the reactor, for the endothermic cracking reaction, is limited by the heat transferred by the catalyst.

Heat flow to the reactor can be increased by pre-

heating the gas oil charge. The slurry oil from the fractionator is a potential source of heat. Sensible heat can be transferred to the feed stream and, thus, provide a means for increasing the charge rate to the unit. In such a case, the exchanger assumes an important role, since the allowable charge rate to the unit is a function of the heat transferred in the exchanger.

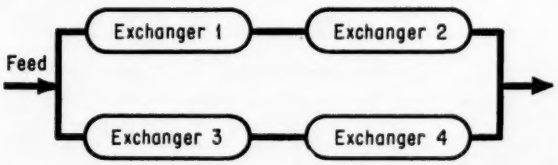
The amount of heat that can be transferred to the feed in the exchanger is given by:

$$q = U A \Delta T_m$$

For a given installation, the area A is fixed. The inlet temperature of the hot slurry oil is set by the operating conditions of the fractionator and will remain relatively constant. Thus, the charge rate to the unit depends upon the over-all coefficient of the exchanger. Under these conditions, it is worthwhile to monitor the heat exchanger coefficient closely.

The coefficient for the exchanger will decrease with service because of fouling. Flow rates through the exchanger will vary over periods of time because of seasonal demands for products, shutdown of associated units, and mechanical difficulties. In order to compare data, taken at varying flow rates, coefficients must be corrected to standard flows.

Corrected coefficients can be used to determine the economic-optimum cycle for cleaning the fouled exchanger. Frequently, several exchangers in series or parallel or both are more satisfactory than a single unit. A typical arrangement, as shown here, allows operation of the unit at a reduced feed rate while a single exchanger is bypassed and cleaned.



If the nature of the fouling is such that a liquid acid or caustic wash or both is sufficient to clean the tubes, the exchanger can be cleaned in place. Such work can usually be accomplished in 24 to 48 hr. and the exchanger returned to service. Removal of the exchanger bundle to an area where the tubes are sandblasted or cleaned mechanically usually requires more time. The use of several exchangers provides more flexibility than a single vessel.

Establish Calculation Procedure

First step in preparing the various charts needed to correct the heat exchanger coefficients to standard flows is to evaluate the film coefficients. Standard flow rates are chosen. These may be either the design rates or the average rates through the exchanger. Dimensions of the exchangers may be obtained from drawings of the units.

Physical properties of the fluids are obtained from reference sources and knowledge of the temperature and pressure in the vessel. Film coefficients are then evaluated by suitable correlations. An excellent review[1,2] of these correlations and methods for evaluating film coefficients has been recently presented.

For this example, the following standard flow rates are set for the shell-and-tube feed-preheat exchanger: shellside rate is 16,000 B/SD and tubeside rate is 20,000 B/SD.

Coefficients are then evaluated and the results are: h_{o_s} is 120 Btu./(hr.)(sq.ft.)(°F.) for the shellside and h_{i_s} is 220 Btu./(hr.)(sq.ft.)(°F.) for the tubeside. Remember that the tubeside coefficient must be corrected to the same area basis as the shellside coefficient.

Film resistance is then calculated from:

$$1/U = 1/h_{o_s} + 1/h_{i_s}$$
$$1/U = 1/120 + 1/220 = 0.01288$$
$$U = 77.6 \text{ Btu./(hr.) (sq. ft.) (°F.)}$$

The term r is found from Eq. (7) to equal 1.83.

The actual coefficient for the exchanger will probably be in the range of 20 to 70 Btu./(hr.)(sq.ft.)(°F.). A chart is then made by calculating various values of a. For U_s equal to 40, the total resistance $1/U_s$ is 0.025. Since fouling resistance equals total resistance minus film resistance, fouling resistance $1/b$ becomes 0.025 minus 0.01288 or 0.01212.

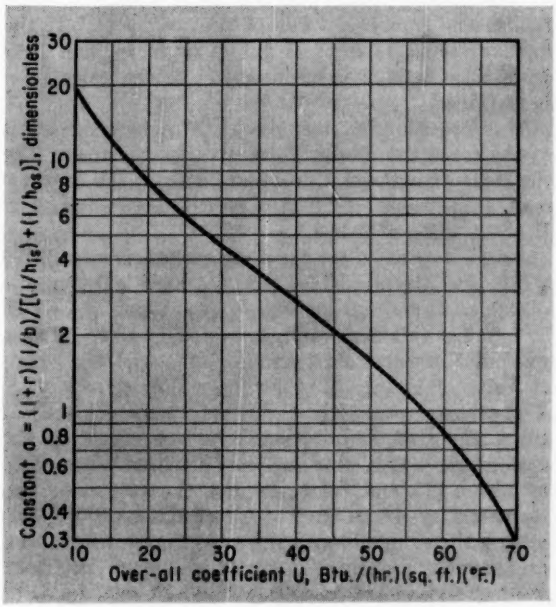
Next, calculate the ratio a from:

$$a = \frac{\text{(fouling resistance)}}{\text{(film resistance)}} (1 + r)$$

$$a = \frac{0.01212}{0.01288} (1 + 1.83) = 2.67$$

Similar calculations lead to the values shown in the

Plot data to determine constant—Fig. 2



table, which are plotted in Fig. 2. The necessary data and charts are now ready to be used.

U	$\frac{1}{U}$	$\frac{1}{h_{oo}} + \frac{1}{h_{io}}$	$\frac{1}{b}$	$\frac{\frac{1}{b}}{\frac{1}{h_{oo}} + \frac{1}{h_{io}}}$	a
70	0.01429	0.01288	0.00141	0.110	0.312
60	0.01667	0.01288	0.00379	0.296	0.836
50	0.02000	0.01288	0.00712	0.554	1.57
40	0.02500	0.01288	0.01212	0.94	2.66
30	0.03333	0.01288	0.02045	1.59	4.50
20	0.05000	0.01288	0.03712	2.88	8.14
10	0.10000	0.01288	0.08712	6.72	19.00

Experimental data, including flow rates and temperatures, are obtained for the shell-and-tube preheat exchanger already mentioned. After correcting the temperature driving force for the number of shell-and-tube passes, an observed coefficient of 65 is obtained. At the time data were taken, flow rate for the shellside was 18,400 B/SD and for the tubeside, 22,100 B/SD.

From Eq. (2) evaluate y_i and y_o, keeping in mind that n is 0.8 for tubeside- and 0.6 for shellside-coefficients. Hence, y_i is $(16{,}000/18{,}400)^{0.8}$ or 0.893, and y_o is $(20{,}000/22{,}100)^{0.6}$ or 0.937.

From Fig. 2 and a value of U equal to 65, the value of a is 0.57. Using Eq. (17), calculate the correction factor F. For this case, F is 0.933. Applying this correction factor to Eq. (4) gives U_{os} as 60.6 Btu./(hr.) (sq. ft.) (°F.).

To be strictly correct, the value of a from Fig. 2 should correspond to the corrected coefficient. Therefore, the above procedure should be repeated, using the value of a corresponding to the calculated value of 60.6.

Repeating, it is found that a is now 0.82 and F is 0.938. The final value of U is calculated to be 60.8, which is very close to the first value of 60.6. Hence, in most cases, a single calculation is sufficient to establish the corrected value of the coefficient. If the first corrected value of U differs by more than 10% from the uncorrected coefficient, a second calculation is justified.

This procedure is now repeated to show the effect of the correction factor F for a dirty exchanger. By the same experimental procedure used in the previous case, a coefficient of 20 is obtained. From Fig. 2 at $U = 20$, value of a is 8.1.

Actual flow rates for the dirty exchanger are 13,100 B/SD for the shellside and 17,200 B/SD for the tubeside. Again using Eq. (2), evaluate y_i, which is 1.17 for this case, and y_o, which is 1.10. Hence, we find F equals 1.04 from Eq. (17) and U_{os} equals 20.8 Btu./(hr.) (sq. ft.) (°F.) from Eq. (2).

These examples show the effect of correcting heat exchanger coefficients to standard flow rates. In the first example, the observed coefficient was decreased by about 7% and in the second, the coefficient was increased by 4%. Since the calculations for determining the economic-optimum cycle for cleaning a heat exchanger are sensitive to variations in the coefficient, the corrections are justified.

ACKNOWLEDGEMENT

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Nomenclature

A	Heat transfer area, sq. ft.
a	Defined by Eq. (8), dimensionless.
b	Fouling factor plus metal resistance, Btu./(hr.)(sq. ft.)(°F.).
B/SD	Barrels per stream day, bbl./day.
F	Correction factor, dimensionless.
f	Fouling factor, dimensionless.
h	Film coefficient, Btu./(hr.)(sq.ft.)(°F.).
h_i	Inside film coefficient, Btu./(hr.)(sq.ft.)(°F.).
h_o	Outside film coefficient, Btu./(hr.)(sq.ft.)(°F.).
h_{is}	Inside film coefficient at standard flow.
h_{os}	Outside film coefficient at standard flow.
k	Thermal conductivity, Btu./(hr.)(sq.ft.)(°F.).
q	Heat transfer rate, Btu./hr.
n	Constant.
r	Ratio, h_{is}/h_{os}.
U	Over-all coefficient, But./(hr.)(sq.ft.)(°F.).
U_{ob}	Observed over-all coefficient.
U_{os}	Over-all coefficient at standard flow.
W	Flow rate, lb./hr.
x	Metal thickness, ft.
y	Ratio of standard film coefficient to observed film coefficient.
y_i	Ratio y for inside coefficients.
y_o	Ratio y for outside coefficients.
ΔT_m	Mean temperature difference, °F.
Φ	Function of.

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Meet the Author

JOSEPH F. FRANTZ *joined the research department of the Lion Oil Division of Monsanto Chemical Co., at El Dorado, Ark., after receiving a Ph.D. degree from Louisiana State University. In 1960, he was promoted to senior chemical engineer. His work at Monsanto includes process development studies and fundamental work in fluidization. Dr. Frantz holds B.S. and M.S. degrees, also from Louisiana State.*

How to Make Distillation Calculations

Apply graphical or analytical methods in the analysis of the material and heat-balance relations for a column, to find minimum reflux and number of theoretical plates.

JESSE COATES and BERNARD S. PRESSBURG
Louisiana State University

We will continue the discussion on distillation that started in the last installment of this series (*Chem. Eng.*, Feb. 20, 1961, p. 145). In that article, we paid most attention to methods of calculating the number of theoretical trays and the column heat requirements by using an enthalpy-concentration diagram.

Now, we'll show how to use this enthalpy-concentration diagram to determine minimum reflux and minimum number of plates. We'll also examine the use of material balance equations and analytical methods for continuous distillation calculations.

How to Find Minimum Reflux

When the upper heat-balance operating line coincides with a tie line at or above the feed point, the equilibrium relation and the operating line are identical and no further separation beyond this point is possible. An infinite number of theoretical trays are required to reach this point. Under these conditions, the reflux ratio L_c/D becomes the minimum below which the required separation is impossible even though an infinite number of trays were available.

For normal systems, such as that represented in Fig. 1, minimum reflux exists when the upper operating line coincides with the feed-point tie line. In this case, the feed-point tie line is extended so that it intersects the abscissa at $(h_D')_{min}$. From this value, $(Q_c)_{min}$ can be obtained. Combining $(h_D')_{min}$ with a heat and material balance around the condenser gives $(L_c)_{min}$. Hence:

$$(V_1)_{min} = (L_c)_{min} + D$$
$$(V_1)_{min} H_1 = (L_c)_{min} h_c + D(h_D')_{min}$$

Evaluate Minimum Number of Plates

When the column operates at total reflux, the number of plates is at a minimum. Under these conditions, the heat-balance operating lines become straight vertical lines. A stepwise procedure from the condenser to the reboiler, using straight vertical operating lines and the corresponding tie lines, is used for getting the minimum number of theoretical plates on the enthalpy-composition line.

Use Material-Balance Equations Only

We have already pointed out the conditions under which the material balances become straight lines:

$$y_{n+1} = \frac{L_n x_n}{V_{n+1}} + \frac{D x_D}{V_{n+1}} \quad (1)$$

$$y_{m+1} = \frac{L_m x_m}{V_{m+1}} - \frac{B x_B}{V_{m+1}} \quad (2)$$

This facilitates their use in determining the number of theoretical trays and makes the use of the heat-balance equations unnecessary for this purpose. To utilize these relations, we must first prepare an equilibrium diagram such as that shown in Fig. 2.

Knowing the thermal condition of the feed, we can evaluate q from the following equation:

$$q = \frac{H_f - I_F}{H_f - h_{f-1}} \quad (3)$$

For saturated liquid feed, q equals one. For saturated vapor feed, q is zero. For feeds that are part vapor, q is approximately equal to the fraction of liquid in the feed. For cold feed below its boiling point, q is greater than one. For superheated vapor feed, q is negative.

The following equation, referred to as the q-line, intersects a line on which $y = x$ at $x = Z_F$:

$$y_i = \left(\frac{q}{q-1}\right) x_i - \frac{Z_F}{q-1} \quad (4)$$

Using this relation and a suitable value of q from above, construct Eq. (4) on the equilibrium diagram. This construction line terminates on the equilibrium line.

Eq. (1) intersects line $y = x$ at $x = x_D$. This line is constructed in Fig. 2 from point x_D to its intersection with the q-line. Eq. (2) intersects line $y = x$ at $x = x_B$. This line is constructed from point x_B to the

intersection of the upper operating line and the q-line.

Using a total condenser and starting at the top, a horizontal line (from $x_D = y_1$) to the equilibrium line gives x_1. A horizontal line (from x_1 at the operating line) gives y_2. A vertical line (from y_2 to the operating line) gives x_2. This results in the construction of steps between the operating line and the equilibrium line as described. Steps are drawn until the value of x becomes equal to or less than x_B.

If a total condenser is used, the number of theoretical plates is one less than the number of steps. If a partial condenser equivalent to one theoretical plate is used, the number of plates is two less than the number of steps. This is the well-known McCabe-Thiele method.[1] Later, we will illustrate this method with an example.

For total reflux, the operating lines become identical with the line $y = x$. The minimum number of plates is stepped off by the method previously described.

As before, minimum reflux occurs when the operating line and the equilibrium line give identical concentrations. For a normal system, such as that used in the example, minimum reflux occurs when the upper operating line and the equilibrium line intersect on the q-line. For abnormal systems, the operating line may become tangent to the equilibrium line above the point of intersection of the q-line and the equilibrium line. The point of tangency then determines the minimum reflux.

Use Analytical Methods When Necessary

Often, it is desirable and necessary to make plate-to-plate calculations rather than use graphical methods. In multicomponent distillation calculations, with few exceptions, plate-to-plate calculations are necessary. In binary distillation, plate-to-plate calculations are sometimes desirable.

Again, we start with the over-all material balance:

$$F = D + B \tag{5}$$

Also, the individual component balance:

$$FZ_F = Dx_D + Bx_B \tag{6}$$

must be satisfied for every component in the mixture.

However, for multicomponent mixtures, we select the components between which separation is desired. These are designated as key components. The composition of one of these in the overhead and that of the other in the bottoms can be fixed. The quantities of the remaining components that appear in the overhead and bottoms must be estimated on the basis of their volatilities with respect to the key components. Eq. (6) cannot be satisfied until this estimate has been made.

For a given reflux ratio, the over-all heat balance equations are satisfied as described in *Chem. Eng.*, Feb. 20, 1961, p. 146. These equations are:

$$FI_F + Q_B = DH_D + Bh_B + Q_C \tag{7}$$

$$FI_F = Dh_D' + Bh_B' \tag{8}$$

Hence, we can obtain the reboiler heat load Q_B and the condenser heat load Q_C by these means.

General procedure would be to start at the condenser and work downward. (If desired, we could start at the reboiler and work upward.) Material and heat-balance relations for the rectifying section are:

$$y_{n+1} = \frac{L_n x_n}{V_{n+1}} + \frac{Dx_D}{V_{n+1}} \tag{9}$$

$$V_{n+1}H_{n+1} = L_n h_n + DH_D + Q_C = L_n h_n + Dh_D' \tag{10}$$

Knowing the composition of the vapor y_1 leaving the top plate, the equilibrium composition of the liquid x_1 is calculated for every component by using a dew point calculation.

For multicomponent systems, Eqs. (9) and (10) are solved, usually by trial-and-error, for L_1, V_2, h_1, H_2 and values of y_2 for every component. Using these values of y_2, a dew point calculation gives x_2 and the temperature on Plate 2. This fixes h_2. Eqs. (9) and (10) are then solved, as before, for L_2, V_3, h_2, H_2 and y_3 for every component. This procedure is repeated until the feed tray is reached.

For binary systems, the feed tray bridges the q-line between the upper and lower operating lines. For multicomponent systems, conditions at the feed tray are much more complicated. Space does not permit as quantitative a treatment. It is sufficient to say, at this point, that the shift is made from the upper to the lower operating line if the use of the lower line results in a more rapid decrease in the liquid composition with respect to the more volatile key component.

Below the feed point, the material balance as given by Eq. (2), and the heat balance as given by:

$$L_m h_m = V_{m+1}H_{m+1} + Bh_B' \tag{11}$$

are applicable. These equations are used, along with equilibrium calculations, in a manner analogous to that described above for conditions above the feed point. Calculations are continued until the reboiler composition is reached.

Plate-to-plate calculations are time consuming but have the advantage of giving the quantities, compositions and temperatures of each stream leaving every plate.

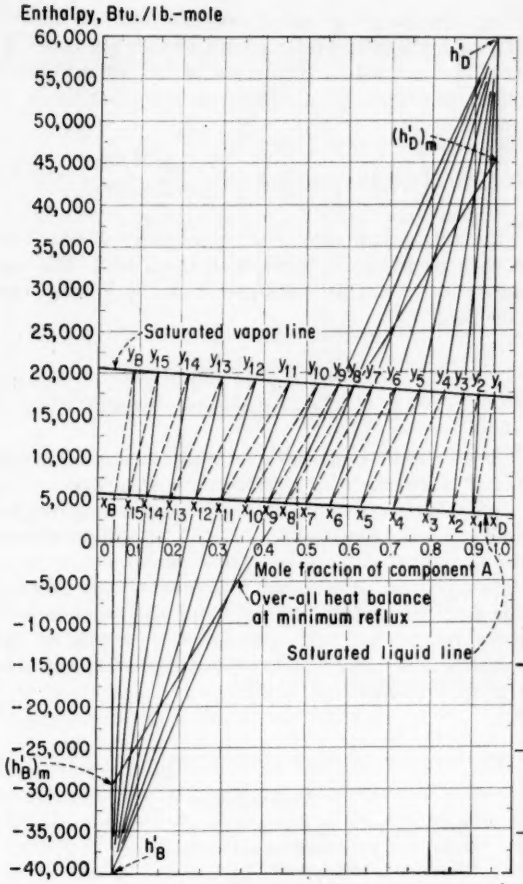
Minimum reflux can be calculated for normal binary systems from:

$$\left(\frac{L_n}{D}\right)_{min} = \frac{x_D - y_i}{y_i - x_i} \tag{12}$$

For this type system, y_i and x_i are related at minimum reflux by:

$$y_i = \frac{qx_i}{q-1} - \frac{Z_F}{q-1} = \frac{\alpha_i x_i}{1 + (\alpha_i - 1)x_i} \tag{13}$$

Eq. (13) represents the intersection of the q-line and the equilibrium line for binary systems. It may be solved for y_i and x_i. If α_i is constant, the equation may be solved directly. Otherwise, trial-and-error is called for. A value of α_i is assigned and x_i is found. A boiling point calculation[2] is now made to check the assumed value of α_i. When the assumed α_i checks the calculated value, the relation is satisfied and $(L_n/D)_{min}$ may be obtained from Eq. (12). No such simple relations are available for minimum reflux ratio in multicomponent distillations.



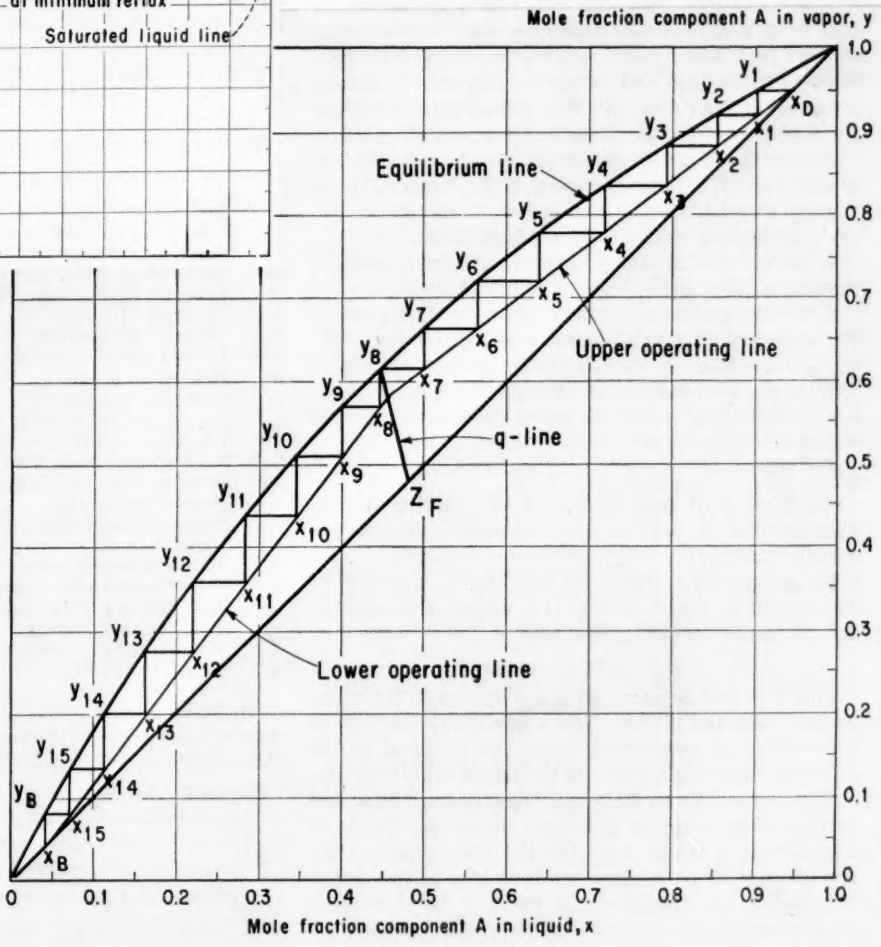
Minimum plates can be calculated for the so-called normal systems by means of the Fenske[3] equation, written here for any two components A and B:

$$S_m = \frac{\log\left(\frac{x_A}{x_B}\right)_D\left(\frac{x_B}{x_A}\right)_B}{\log\alpha_{av}} \quad (14)$$

$$\alpha_{av} = \sqrt{(\alpha_{AB})_D(\alpha_{AB})_B} \quad (15)$$

If a total condenser is employed, $S_m = n + 1$. If a partial condenser, equivalent to one theoretical plate is used, $S_m = n + 2$. For binary systems, the only components present would be A and B. For multicom-

◂Enthalpy-composition diagram—Fig. 1
McCabe-Thiele equilibrium diagram—Fig. 2



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ponent mixtures, A and B would be the key components.

Example Illustrates McCabe-Thiele Method

Feed to a distillation column consists of 48 mole % component A and 52 mole % component B. This mixture is to be separated into a distillate containing 95 mole % A and a bottoms product containing 4 mole % A. The feed contains 20 mole % vapor. A total condenser will be used and column will operate at a total pressure of one atm. At this pressure, the boiling point of pure A is 195 F. and that of pure B is 242 F.

Assuming constant molal overflow and vapor upflow in any section of the column, use the McCabe-Thiele method to calculate the number of theoretical plates for a pumpback reflux ratio L_c/D of 2.922.

What are the minimum number of plates and the minimum reflux ratio that can be used?

Since constant molal overflow and vapor upflow occur, the operating-line equations are straight lines. The equilibrium diagram for this system is shown in Fig. 2.

With the feed containing 20 mole % vapor, q equals 0.8. Substituting in Eq. (4) gives the equation for the q-line, which becomes:

$$y = -4x_i + 2.4$$

Construct this line on Fig. 2 by starting on the diagonal line ($y = x$) at $Z_F = 0.48$ and ending on the equilibrium line.

By substituting the value for (L_n/V_{n+1}), which is 2.922/3.922 or 0.745, in Eq. (1), we get the equation for the upper operating line as:

$$y_{n+1} = 0.745x_n + 0.242$$

Plot this line from x_D on the diagonal to its intersection with the q-line. The lower operating line is constructed by connecting x_B on the diagonal to the intersection of the q-line and the upper operating line.

Starting at the condenser, successive horizontal and vertical lines forming steps are drawn as shown in Fig. 2. The step that straddles the intersection of the operating lines shows that the feed tray is the eighth tray below the condenser. A total of 15 theoretical trays plus the reboiler and condenser are required.

At minimum reflux for this system, the upper operating line, the q-line and the equilibrium line intersect at a common point. Coordinates of this point are $y = 0.617$ and $x = 0.446$. Hence, we can calculate minimum reflux, per mole of distillate by substituting in Eq. (12):

$$\left(\frac{L_n}{D}\right)_{min} = \left(\frac{L_c}{D}\right)_{min} = \frac{0.95 - 0.617}{0.617 - 0.446} = 1.95$$

For this system, the relative volatility of component A with respect to B is constant at α_{AB} of 2. Minimum theoretical plates are obtained from the Fenske[3] equation:

$$S_m = \frac{\log\left(\frac{0.95}{0.05}\right)\left(\frac{0.96}{0.04}\right)}{\log 2} = 8.85$$

Since a total condenser was used, the minimum number of theoretical plates is one less than 8.85 or 7.85.

We might use the calculation methods given here and in *Chem. Eng.*, Feb. 20, 1961, p. 145 to measure the performance of an existing column.

In our next article, we will discuss tray efficiency and consider factors such as liquid and vapor capacity, pressure drop and tray spacing. A knowledge of these subjects is necessary before we can calculate the actual size of a column.

Nomenclature

B	Bottoms rate, moles/unit time.
D	Distillate rate, moles/unit time.
F	Feed rate, moles/unit time.
H	Enthalpy of vapor, Btu./lb.-mole.
H_D	Enthalpy of distillate, Btu./lb.-mole.
h	Enthalpy of liquid, Btu./lb.-mole.
h_B	Enthalpy of bottoms, Btu./lb.-mole.
h_B'	Defined as $h_B - (Q_B/B)$.
h_D'	Defined as $H_D + (Q_C/D)$.
I_F	Enthalpy of feed, Btu./lb.-mole.
L	Liquid rate, moles/unit time.
L_c	Pumpback reflux rate, moles/unit time.
Q_B	Reboiler heat load, Btu./unit time.
Q_C	Condenser heat load, Btu./unit time.
q	Defined by Eq. (3).
S_m	Minimum theoretical plates as defined by Eq. (14).
V	Vapor rate, moles/unit time.
x	Mole fraction of component in liquid.
x_B	Mole fraction of component in bottoms.
x_D	Mole fraction of component in distillate.
y	Mole fraction of component in vapor.
Z_F	Mole fraction of component in feed.
α	Relative volatility.

Subscripts

$m, m+1$, etc.	Plates in stripping section.
$n, n+1$, etc.	Plates in rectifying section.

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1. McCabe, W. L. and E. W. Thiele, *Ind. Eng. Chem.*, **17**, 605 (1925).
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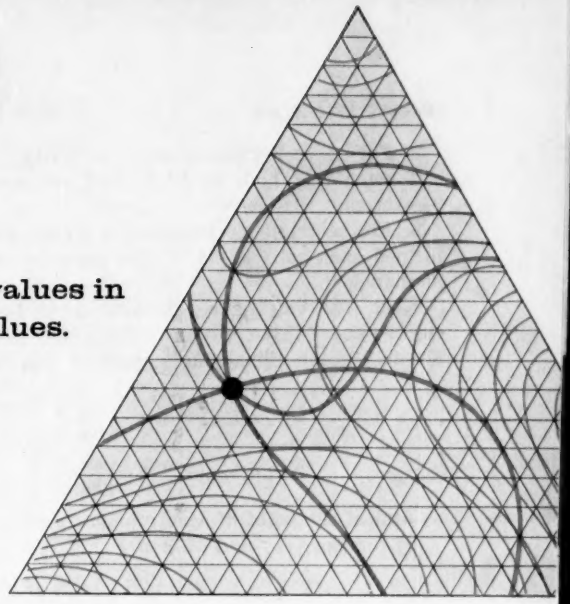
3. Fenske, M. R., *Ind. Eng. Chem.*, **24**, 482 (1932).

Graphical Prediction of Ternary Azeotropes

By straightforward calculation and graphing, this method gives values in good agreement with literature values.



PAUL J. HORVATH, *B. F. Goodrich Chemical Co.*

If attempts are made to design stills for ternary systems without knowledge of the basic vapor-liquid behavior, it is possible that the stage-to-stage calculations will run into a "pinch" condition. This pinch can be caused either by the formation of a ternary azeotrope or by an assumed reflux ratio less than the minimum. Lacking knowledge of the vapor-liquid behavior, one can't determine whether the difficulty is caused by the former or the latter. Thus, it is apparent that a technique is needed that will predict the existence, composition and temperature of ternary azeotropes.

Probably the most common method to determine ternary azeotropic points is by experiment. But this approach can lead to some serious difficulties. If the amounts of the three components charged to the equilibrium still are not judiciously chosen, for example, the ternary azeotrope might not be formed.

A second approach is the mathematical determination of the existence of azeotropes. Work has been done along these lines, and some literature references can be found.[2-6] These mathematical techniques, including those in which graphical methods are used,[5,6] are all rather lengthy and cumbersome. Some cannot be used when there are immiscible phases,[4] thus excluding a great number of systems.

Calculation methods in the literature are based on extrapolation of easily obtainable binary data to ternary systems. Unfortunately, there is no easy way to examine binary data and predict ternary azeotropes. Existence or nonexistence of binary azeotropic pairs among the three components is not a criterion for predicting the existence of a ternary azeotrope. Even the existence of three binary azeotropes among the components of the ternary mixture is not necessary or sufficient for formation of a ternary azeotrope.

We have developed a method for predicting ternary azeotropes that we believe is simpler to use than any of the others published. Systems containing either heteroazeotrope or homoazeotrope binary pairs, or combinations of them, can all be handled with equal ease. The results obtained with this technique are in remarkably close agreement with those published in the literature.

Our method involves some straightforward calculations, followed by a final trial-and-error graphic solution. The graphical steps are done on ternary coordinate paper. After the first two trials, convergence upon a ternary azeotropic point can be easily seen. In nonazeotropic cases, divergence is noted.

As in the case with other published techniques, this method also uses binary vapor-liquid equilibrium data for each of the three binary pairs, as a starting point. These data are easy to obtain experimentally with an equilibrium still and, in many cases, they can be found in the literature. Using this method, we have calculated several ternary systems, and the results, along with published experimental data, are shown in Table II (p. 161).

Note that most of the azeotropic systems agree quite well with published data, with the possible exception of the acetone-chloroform-methanol system. But for this case, the Haase approach[2] results in a calculated composition of 13% acetone, 40% chloroform and 47% methanol. So though our technique did not result in good agreement, nevertheless it is more accurate than the Haase method.

Now we'll illustrate the step-by-step application of this technique for the acetone-methanol-cyclohexane system. Nomenclature that follows will be used.

A	van Laar constants
P	vapor pressure of pure components, mm. Hg
P_t	total system pressure, mm. Hg
x	concentration in liquid phase, mole fraction, unless otherwise noted
y	concentration in vapor phase, mole fraction
γ	activity coefficients

Subscript 1 is most volatile compound, 3 is least volatile, 2 is of intermediate volatility.

Obtaining the van Laar Constants

Data for the three binary systems are obtained by experiment or from the literature. For the system acetone-methanol-cyclohexane, we find the following in the literature:[1]

1. For acetone-methanol, a binary azeotrope is formed that boils at 55.5 C. and contains 12.0 wt. % methanol.

2. For acetone-cyclohexane, a binary azeotrope is formed that boils at 53 C. and contains 67.0 wt. % acetone.

3. For methanol-cyclohexane, a binary azeotrope is formed that boils at 54 C. and contains 38.0 wt. % methanol.

Next, the van Laar constants must be evaluated for the above three systems. Since they are all homoazeotropes, the following equations can be used:

$$A_{1-2} = \log \gamma_1 \left[1 + \frac{x_2 \log \gamma_2}{x_1 \log \gamma_1} \right]^2 \quad (1)$$

$$A_{2-1} = \log \gamma_2 \left[1 + \frac{x_1 \log \gamma_1}{x_2 \log \gamma_2} \right]^2 \quad (2)$$

And at the point of azeotropism, γ_1 and γ_2 are evaluated for Eqs. (1) and (2):

$$\gamma_1 = P_t / P_1 \quad (3)$$

$$\gamma_2 = P_t / P_2 \quad (4)$$

where P_1 and P_2 are evaluated at the azeotropic temperature. After converting the compositions of the three binary systems from weight percent to mole fraction, and after evaluating the activity coefficients at the azeotropic point, the data were put into Eqs. (1) and (2). The following van Laar constants were calculated:

For acetone-methanol, $A_{1-2} = 0.19142$, $A_{2-1} = 0.34836$
For acetone-cyclohexane, $A_{1-3} = 0.65820$, $A_{3-1} = 0.80355$
For methanol-cyclohexane, $A_{2-3} = 0.96881$, $A_{3-2} = 1.25990$

To avoid confusion, it is always wise to arrange the components in increasing order of boiling points. In the above constants, subscript 1 refers to acetone, 2 refers to methanol and 3 to cyclohexane.

In this example, all three systems are homoazeotropes. Eqs. (1) and (2) apply. We recognize that

Ternary activity coefficients for example—Table I

x_1, wt. %	x_2, wt. %	x_3, wt. %	γ_1	γ_2	γ_3
1.000	1.000	98.000	3.875	8.308	1.002
1.000	5.000	94.000	2.640	6.044	1.031
1.000	10.000	89.000	1.955	4.334	1.110
1.000	20.000	79.000	1.463	2.631	1.402
1.000	30.000	69.000	1.324	1.872	1.893
1.000	40.000	59.000	1.296	1.483	2.640
1.000	50.000	49.000	1.313	1.266	3.721
1.000	60.000	39.000	1.351	1.140	5.241
1.000	70.000	29.000	1.398	1.066	7.324
1.000	80.000	19.000	1.449	1.024	10.115
1.000	90.000	9.000	1.502	1.005	13.778
1.000	95.000	4.000	1.528	1.001	15.993
1.000	98.000	1.000	1.544	1.000	17.458
5.000	1.000	94.000	3.414	7.513	1.011
5.000	5.000	90.000	2.404	5.505	1.053
5.000	10.000	85.000	1.830	3.982	1.146
5.000	20.000	75.000	1.412	2.457	1.471
5.000	30.000	65.000	1.298	1.773	2.006
5.000	40.000	55.000	1.282	1.423	2.813
5.000	50.000	45.000	1.306	1.228	3.979
5.000	60.000	35.000	1.348	1.115	5.612
5.000	70.000	25.000	1.398	1.050	7.845
5.000	80.000	15.000	1.451	1.016	10.831
5.000	90.000	5.000	1.505	1.001	14.741
5.000	94.000	1.000	1.527	1.000	16.606
10.000	1.000	89.000	2.946	6.629	1.034
10.000	5.000	85.000	2.156	4.903	1.091
10.000	10.000	80.000	1.695	3.587	1.204
10.000	20.000	70.000	1.356	2.261	1.573
10.000	30.000	60.000	1.270	1.662	2.168
10.000	40.000	50.000	1.267	1.354	3.058
10.000	50.000	40.000	1.298	1.184	4.339
10.000	60.000	30.000	1.345	1.088	6.128
10.000	70.000	20.000	1.398	1.034	8.567
10.000	80.000	10.000	1.454	1.008	11.818
10.000	85.000	5.000	1.482	1.002	13.805
10.000	89.000	1.000	1.505	1.001	15.589
20.000	1.000	79.000	2.272	5.180	1.118
20.000	5.000	75.000	1.780	3.910	1.206
20.000	10.000	70.000	1.482	2.931	1.361
20.000	20.000	60.000	1.265	1.931	1.832
20.000	30.000	50.000	1.224	1.475	2.569
20.000	40.000	40.000	1.244	1.241	3.657
20.000	50.000	30.000	1.288	1.114	5.210
20.000	60.000	20.000	1.344	1.046	7.366
20.000	70.000	10.000	1.403	1.014	10.285
20.000	75.000	5.000	1.433	1.006	12.088
20.000	79.000	1.000	1.457	1.004	13.718
30.000	1.000	69.000	1.828	4.082	1.259
30.000	5.000	65.000	1.518	3.149	1.383
30.000	10.000	60.000	1.327	2.424	1.587
30.000	20.000	50.000	1.197	1.674	2.185
30.000	30.000	40.000	1.191	1.330	3.101
30.000	40.000	30.000	1.229	1.156	4.440
30.000	50.000	20.000	1.285	1.067	6.334
30.000	60.000	10.000	1.347	1.024	8.943
30.000	65.000	5.000	1.380	1.014	10.573
30.000	69.000	1.000	1.405	1.011	12.056
40.000	1.000	59.000	1.530	3.261	1.470
40.000	5.000	55.000	1.334	2.577	1.636
40.000	10.000	50.000	1.215	2.040	1.903
40.000	20.000	40.000	1.148	1.480	2.663
40.000	30.000	30.000	1.170	1.225	3.808
40.000	40.000	20.000	1.222	1.100	5.463
40.000	50.000	10.000	1.287	1.042	7.786
40.000	55.000	5.000	1.322	1.029	9.254
40.000	59.000	1.000	1.349	1.023	10.599
50.000	1.000	49.000	1.326	2.660	1.772
50.000	5.000	45.000	1.205	2.157	1.993
50.000	10.000	40.000	1.135	1.759	2.339
50.000	20.000	30.000	1.115	1.343	3.308
50.000	30.000	20.000	1.158	1.157	4.747
50.000	40.000	10.000	1.223	1.074	6.806
50.000	45.000	5.000	1.259	1.054	8.124
50.000	49.000	1.000	1.289	1.045	9.340
60.000	1.000	39.000	1.188	2.237	2.199
60.000	5.000	35.000	1.116	1.863	2.490
60.000	10.000	30.000	1.081	1.566	2.940
60.000	20.000	20.000	1.096	1.259	4.182
60.000	30.000	10.000	1.156	1.129	6.001
60.000	35.000	5.000	1.193	1.098	7.181
60.000	39.000	1.000	1.223	1.084	8.278
70.000	1.000	29.000	1.096	1.966	2.800
70.000	5.000	25.000	1.057	1.682	3.184
70.000	10.000	20.000	1.048	1.458	3.772
70.000	20.000	10.000	1.089	1.232	5.371
70.000	25.000	5.000	1.124	1.178	6.425
70.000	29.000	1.000	1.155	1.152	7.414
80.000	1.000	19.000	1.038	1.839	3.647
80.000	5.000	15.000	1.023	1.614	4.156
80.000	10.000	10.000	1.032	1.439	4.926
80.000	15.000	5.000	1.058	1.334	5.865
80.000	19.000	1.000	1.086	1.282	6.753
90.000	1.000	9.000	1.008	1.876	4.849
90.000	5.000	5.000	1.009	1.683	5.525
90.000	9.000	1.000	1.026	1.559	6.320
95.000	1.000	4.000	1.001	1.979	5.630
95.000	4.000	1.000	1.006	1.829	6.203
98.000	1.000	1.000	1.000	2.078	6.170

Comparison of data—Table II

Component			Calculated				Published[1]			
			Comp. Wt. %			Temp.	Comp. Wt %			Temp.
a	b	c	a	b	c	°C.	a	b	c	°C.
Acetone	Methanol	Cyclohexane	47.5	14.0	38.5	53	43.5	16.0	40.5	51.1
Isopropanol	Water	Nitromethane	64.5	8.5	27.0	78	62.0	6.0	32.0	78.0
Ethanol	Ethyl acetate	Water	11.0	82.5	6.5	70	8.4	82.6	9.0	70.23
Chloroform	Ethanol	Water	96.5	1.0	2.5	55	92.5	4.0	3.5	55.4
Ethanol	Benzene	Water	27.0	71.0	2.0	68	18.5	74.1	7.4	64.86
Acetone	Chloroform	Methanol	42.5	38.5	19.0	56	30.0	47.0	23.0	56.4
Carbon tetrachloride	Ethanol	Benzene		Nonazeotrope				Nonazeotrope		
n-Heptane	2-butanone	Toluene		Nonazeotrope				Nonazeotrope		

there are other equations derived for calculating van Laar constants in heteroazeotropic systems.[2] These equations use mutual solubilities at the azeotropic temperature as a starting point for evaluating the van Laar constants. Although constants so calculated do represent accurately the miscible region of the binary systems in question, they have been found to yield erroneous results with the method described here. Thus, Eqs. (1) and (2) are also recommended for heteroazeotropic systems.

If the binary system in question is not an azeotrope, then the activity coefficients can be calculated from one vapor-liquid equilibrium point:

$$\gamma_1 = \frac{y_1 P_t}{x_1 P_1} \qquad (5)$$

$$\gamma_2 = \frac{y_2 P_t}{x_2 P_2} \qquad (6)$$

where P_1 and P_2 are evaluated at the equilibrium temperature. These values can then be used in Eqs. (1) and (2).

Since this method of predicting ternary azeotropes is based upon use of the van Laar constants, it is obvious that the same limitations imposed upon the use of the constants also apply to the method. In cases where the data cover a wide range of temperature, or where the systems are widely nonsymmetrical (i.e., where one A is more than double the other) good results cannot be expected from the final ternary azeotropic prediction.

Ternary Activity Coefficients

To evaluate γ_1, γ_2 and γ_3, we put the calculated van Laar constants into the Wohl equation,[3] along with various values of x_1, x_2 and x_3. The Wohl equation is written:

$$\log \gamma_1 \left(x_1 + x_2 \frac{A_{2-1}}{A_{1-2}} + x_3 \frac{A_{3-1}}{A_{1-3}} \right)^2 = [x_2^2 (A_{2-1})^2/A_{1-2}] + [x_3^2 (A_{3-1})^2/A_{1-3}] + \left[\left(x_2 x_3 \frac{A_{2-1} A_{3-1}}{A_{1-2} A_{1-3}} \right) \left(A_{1-2} + A_{1-3} - A_{3-2} \frac{A_{1-3}}{A_{3-1}} \right) \right] \qquad (7)$$

Similar equations can be written for log γ_2 and log γ_3 by changing the subscripts in Eq. (7), according to the following table of rotation:

Subscript in Eq. (7) for		
Log γ_1	Log γ_2	Log γ_3
1	2	3
2	3	1
3	1	2

Thus, when solving for log γ_2, x_1 becomes x_2, x_2 becomes x_3, x_3 becomes x_1, A_{1-2} becomes A_{2-3}, etc.

It is possible to solve the Wohl equation with a slide rule and desk calculator, but it is more desirable to use a computer. Activity coefficients for a sufficient number of concentration points must be calculated (many) to define completely the ternary system. In this particular problem, a Bendix G-15D digital computer was programmed to solve the Wohl equation. Table I shows the results at 99 different concentration levels.

The Gamma Maps

The activity coefficients from Table I are plotted on three separate ternary concentration diagrams, one for each of the activity coefficients. We call these plots "gamma maps." Fig. 1 is the map of γ_1. Plotting these maps is necessary to simplify subsequent interpolations, since interpolations from Table I would be quite difficult.

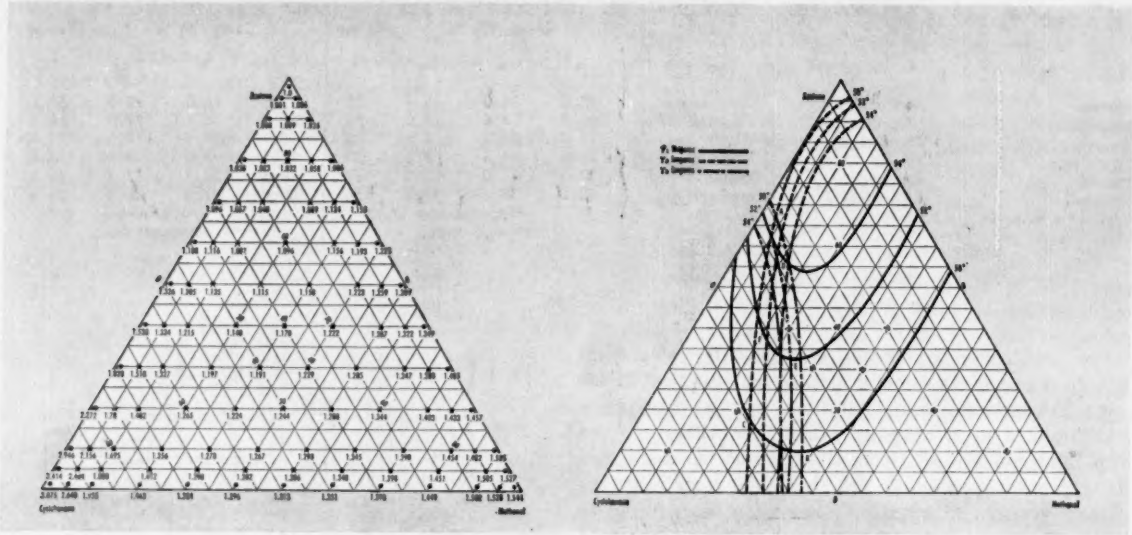
Next we must examine the conditions for an azeotrope to exist. The following Eq. (8) is basic:

Activity coefficients for example—Table III

EVALUATION of the activity coefficient for each component of the example system (acetone-methanol-cyclohexane) is obtained by using Eqs. (11a), (11b) and (11c). The three trial temperatures are at total pressure P_t = 760 mm. Hg.

Trial temp., deg. C.	P_1	P_2	P_3	γ_1	γ_2	γ_3
50	600	401	267	1.267	1.858	2.846
52	645	445	290	1.178	1.708	2.621
54	690	485	310	1.101	1.567	2.452

Here's how calculations are graphed (third step, p. 164)



FIRST step is to plot each of the three activity coefficients on a separate ternary diagram. From data of Table I, the above graph shows "gamma map" of γ_1.

SECOND step is to plot "isograms," i.e., lines connecting points of equal gamma values, on another ternary diagram at the temperatures of interest, look for convergence.

$$y_1 + y_2 + y_3 = 1 \qquad (8)$$

where y's are mole fractions in the vapor phase.

Now, for any system, we can write:

$$y_1 = x_1 \gamma_1 P_1/P_t \qquad (9a)$$

$$y_2 = x_2 \gamma_2 P_2/P_t \qquad (9b)$$

$$y_3 = x_3 \gamma_3 P_3/P_t \qquad (9c)$$

And in azeotropic systems, the following is true:

$$x = y \qquad (10)$$

That is, the concentration of any component is the same in both liquid and vapor phases.

By rearranging Eqs. (9), and substituting the relationship shown in Eq. (10), we have:

$$\gamma_1 = P_t/P_1 \qquad (11a)$$

$$\gamma_2 = P_t/P_2 \qquad (11b)$$

$$\gamma_3 = P_t/P_3 \qquad (11c)$$

Eqs. (11) enable us to determine the value each activity coefficient must have, if an azeotrope exists at the temperature at which the vapor pressures P_1, P_2 and P_3 were evaluated.

For our system, Table III shows activity coefficients at three trial temperatures, using Eqs. (11).

The Final Solution

Let us assume that an azeotrope exists for the acetone-methanol-cyclohexane system at 50 C. From Table III, we see that if this assumption is correct, then γ_1 must be 1.267, γ_2 must be 1.858 and γ_3 must be 2.846. Starting with Fig. 1, the gamma map of γ_1, we interpolate the value $\gamma_1 = 1.267$ and determine the path of the "isogam"* at this value. This is then plotted on a separate ternary graph (Fig. 2). Similarly, the isogams $\gamma_2 = 1.858$ and $\gamma_3 = 2.846$ are interpolated from their gamma maps and plotted along with the isogam for γ_1. If the three isogams have a common intersection, an azeotrope exists at 50 C. If not, we try another temperature.

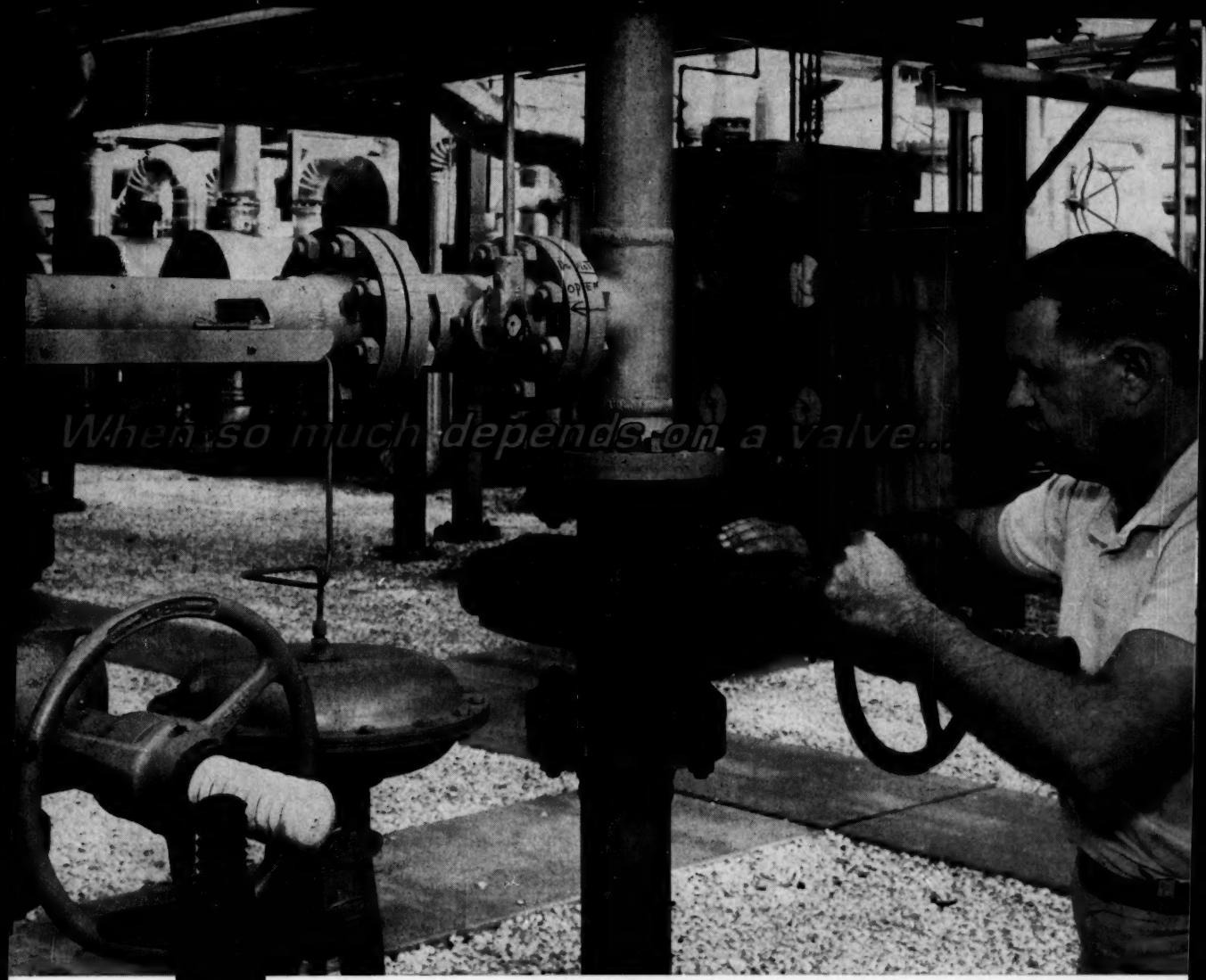
The trials for 50 C., 52 C. and 54 C. are shown in Fig. 2. The interpolations for the activity coefficients, from the gamma maps such as Fig. 1, were made linearly. Although coefficients aren't exactly linear, this approximation does not introduce serious error.

Note, in Fig. 2, how γ_1 moves upward with temperature, γ_2 moves to the right and γ_3 moves to the left. We can see how we are converging on a point at which all three isogams will intersect. At 50 C., we note that the composition lies between the points A, B and C; a triangle has been drawn along the 50 C. isogams surrounding the area. Similarly, at 52 C., a triangle drawn along these isogams, DEF, surrounds a still smaller area lying completely within the area in ABC. But at 54 C., it can be seen that we have gone too far, and the triangle no longer exists.

Thus, the temperature lies between 52 C. and 54 C. On the graph of Fig. 3, the isogams for 53 C. have been constructed. The triangle has been reduced nearly to a point. Further temperature estimation could be made, but since the method is limited in accuracy by the original binary data, the calculated van Laar constants, the calculated ternary activity coefficients and the graphical interpolations, finer temperature adjustments would be meaningless.

From this graph of Fig. 3, we predict that an azeotrope exists at 53 C., and it contains 47.5% acetone, 14.0% methanol and 38.5% cyclohexane. This compares well with the handbook results of 51.1 C., with

*An isogam is a line connecting points of equal γ values.



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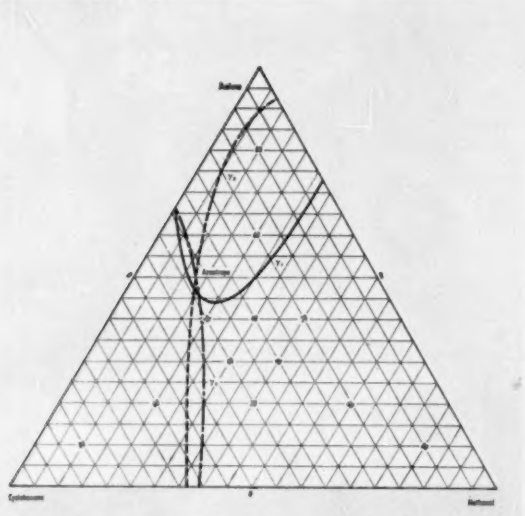

THIRD step is to refine second-step procedure to find the azeotropic point. For example system, azeotrope occurs at 53 C. with 47.5% acetone, 14.0% methanol.

a composition of 43.5% acetone, 16.0% methanol and 40.5% cyclohexane.

It should be noted that the isogams of different systems can assume altogether different shapes than those illustrated by this system. Convergence in these systems, however, is always easily found. When there is no convergence, there can be no common intersection and no azeotrope.

Summing Up the Method

1. Determine (experimentally or from the literature) the vapor-liquid equilibrium relationships of the three binary systems present in the ternary system.
2. Evaluate the van Laar constants for each of the three binary systems.
3. Using the Wohl equation, calculate a sufficient number of ternary activity coefficients to permit construction of the three ternary gamma maps.
4. Assume several temperatures, and calculate the activity coefficients necessary for the formation of a ternary azeotrope at each assumed temperature.
5. Plot these activity coefficient isogams on ternary graph paper, and look for a convergence that will result in a common intersection. If a common intersection exists, there is an azeotrope; if not, there isn't.

The systems chosen to illustrate this technique (Table II) demonstrate clearly the different types of systems that can be handled. Among the azeotropic systems listed, the first contains three binary minimum boiling homoazeotropes; the next four systems contain two minimum boiling azeotropes and one heteroazeotrope; the sixth system contains two minimum boiling homoazeotropes and one maximum boiling homoazeotrope. Of the two nonazeotropic systems, the seventh system contains two minimum boiling homoazeotropes and one nonazeotropic pair; the eighth system contains one minimum boiling homoazeotrope and two nonazeotropic pairs. Thus, many different types of systems can be handled successfully.

Some systems, however, can cause difficulty. As mentioned before, the limitations applying to use of the van Laar equation apply to this technique. In some rare cases, convergence of the three isogams may be difficult to detect. Sometimes, all three isogams move in the same direction with temperature, but at different rates. Sometimes two different isogams may lie so close together that detecting a common intersection for all three may be difficult. One such system is that of carbon disulfide-methanol-ethyl bromide, a system recently used for illustration by Klein.[4] It is, of course, necessary that valid binary data be used in all cases, for the final result of this method can be no better than the starting data.

In spite of these few problem cases, we believe this method for predicting ternary azeotropes can be reliably used for a great number of systems.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to his colleague, Mr. Spyros Evnochides, for the invention of the word "isogam," without which the phrase "lines of activity coefficients of equal magnitude" would have been iterated many times.

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Meet the Author

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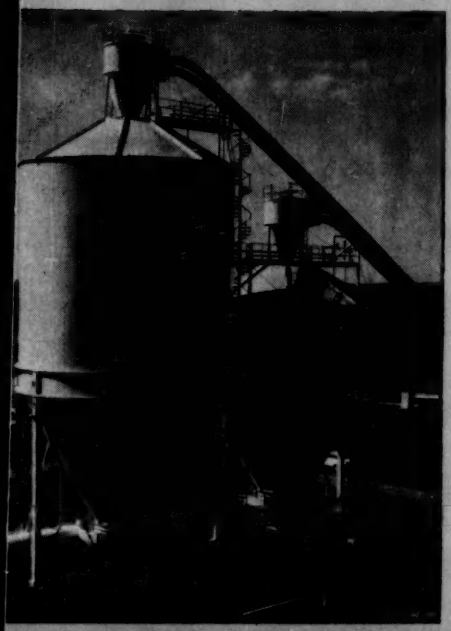

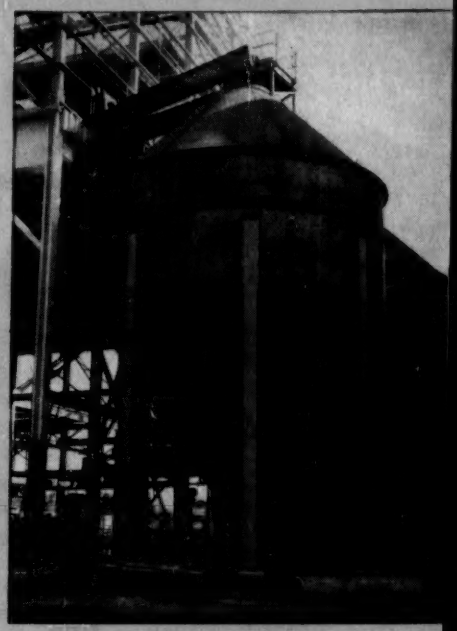

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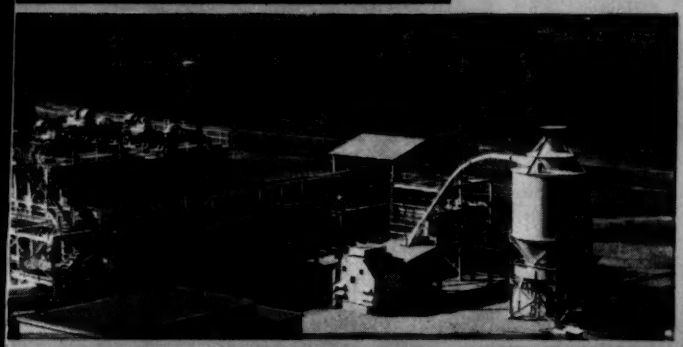
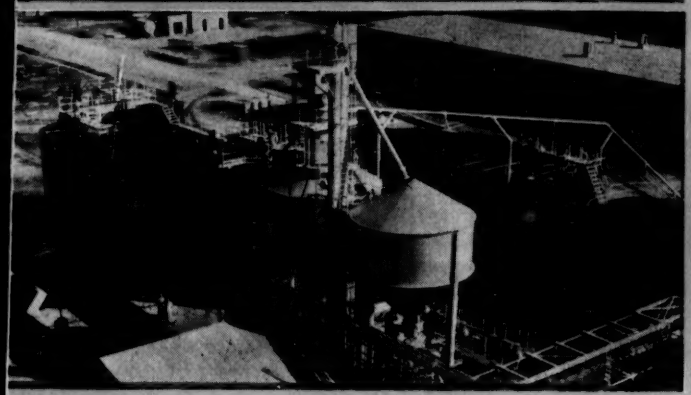
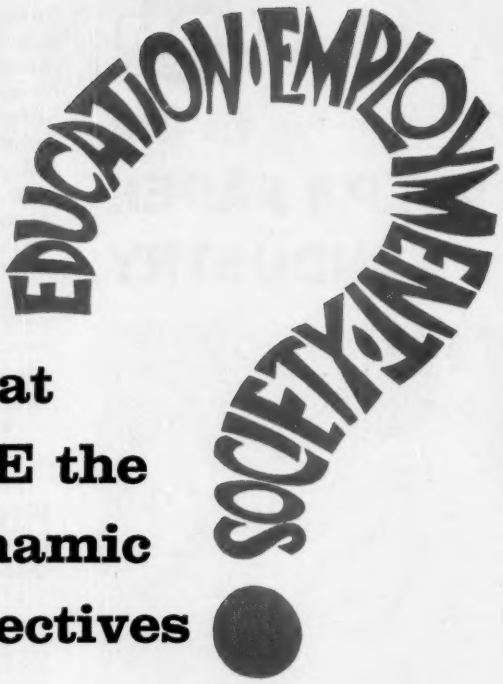




37 Steel Tanks and Bins for Tennessee River Pulp and Paper Co. at Counce, Tenn.

Chemical engineers now seek "dynamic objectives" for their future. If some important questions aren't asked by their representatives, can any answers be guidance for growth?



What ARE the Dynamic Objectives

WILLIAM C. SCHALL, *Associate Editor*

The past several years have been filled with debate—sometimes keen, sometimes desultory—about objectives. Not escaping this relentless questioning, the chemical engineering profession has shared in it.

A focal point of the profession's interest in itself has been the AIChE committee on dynamic objectives.* Charged in mid-1959 to render "a directive of what needs to be done today, and for the near tomorrow, which would enable our profession to make a maximum contribution," the committee went to work. Findings were presented last December at the Washington meeting of the Institute, for discussion before a final report.

Cloaked in the challenge-and-response of formal, academic disputation, the preliminary report disclaims completeness and "absolute" consistency. In view of the disclaimer, it's necessary to ask, first, if a report so prefaced can serve as basis for a directive for policy considerations. Second, if the committee has felt the need to compromise its views this way, what are the gaps that require cementing?

My purpose here is not to be hypercritical. It's evident that the distinguished professionals who prepared the report spent many hours—their own and their employers'—in trying to shape its text from sometimes inchoate, sometimes contradictory testimony. And though they rushed into print without tight editing to give the results public airing, they deserve credit for preparing a springboard to promote thought and discussion.

Accepting the report in this spirit, I would like to raise some questions here about three major areas of concern to the chemical engineer:

- His initial and continuing education, formal and informal.
- The conditions of his career role in society, i.e., the employee-employer relationship.
- The collective responsibilities of engineers who are urged at every turn to act as individuals.

Although the committee's report purports to speak for the profession, it's debatable whether its findings make enough sense to receive the necessary individual approval for profession-wide acceptance. What counts here is the engineer's apartness from, and his participation in, the communities of his peers and of his fellow-citizens. His search for identity in a world of continuing rapid transition is shared with those of his neighbors. But he will support only leadership that provides guidelines that square fairly well with his perception of the realities—whether in civic, professional or moral areas.

Because it is an individual matter, one might ask what individual objectives can be formulated before turning to group objectives. Broadly, I think, they include:

- **Self-examination.** Critically analyzing your present performance and aspirations.
- **Self-improvement.** Renewing your technical reservoir, dipping into containers of new knowledge.
- **Rationalization or realization.** Rebalancing personal and company goals to give full measure to both.
- **Improvement of profession.** Determining to what extent the concept of "engineer" is a collective responsibility.
- **Service to society.** Responding to needs of the lay public, of the community in which you live.

Though there can be little doubt that the individual must have prime responsibility for these objectives, their fulfillment requires sympathetic participation by the universities, by engineering employers and by the professional and technical societies. But since all these groups are institutions, it means that the real par-

* On the committee: nine educators, five managers, three engineers. A report of the committee's first year and a half of work is available from AIChE, 25 W. 45 St., New York 36, N. Y.

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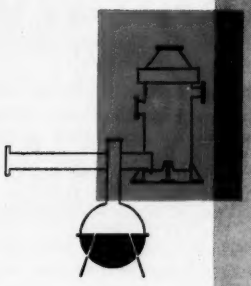
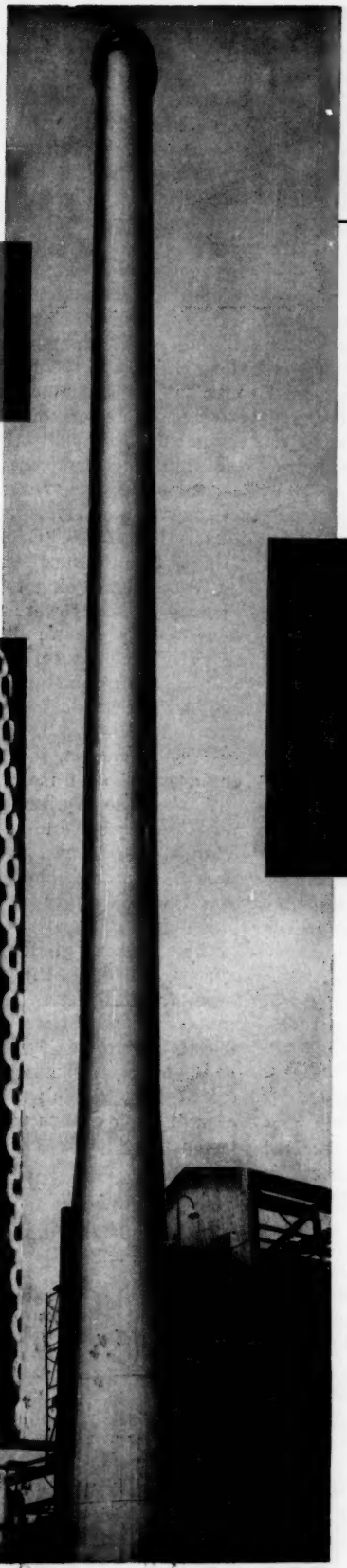
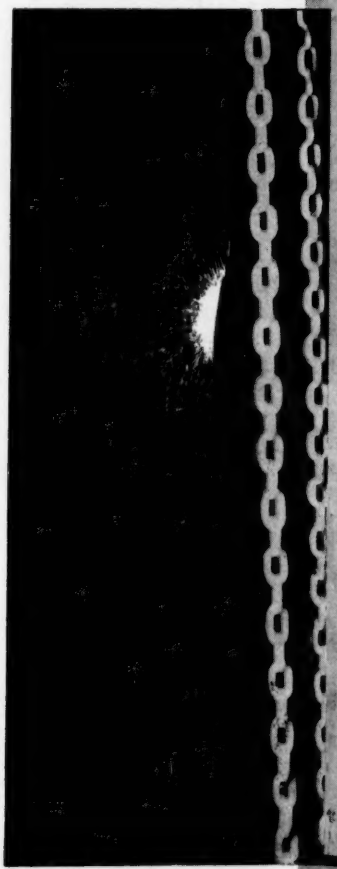




Left: Self-supporting stack of carbon and stainless steel for the Chemicals Plant Division of Blaw-Knox, used at an Atlantic Refining Company refinery. Below: 10′ OD x 50′ after cooler, composed of high tensile steel, for the Columbian Carbon Company.



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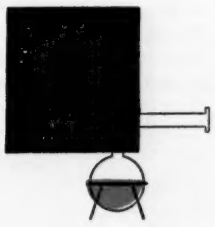

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ticipation is that of educators, managers and society leaders. And one of the greatest dilemmas the profession faces, I believe, is that the objectives and perceptions of these necessary participants in the engineer's lot don't always complement those of the engineer.

Nothing . . . But Education and Culture

Let's first take a look at education. As you might expect from the makeup of the committee, there is considerable space devoted to this area in the dynamic objectives report. And, fittingly, a good part of the text is concerned with the "terminal" curriculum, i.e., the four-year undergraduate course. There's a full description of suggested courses, term by term.

The really shocking revelation here is that chemical engineering educators evidently feel that there is nothing wrong with a recommendation that carries, by my count, only 13% "liberal" (social-humanistic) courses sprinkled in the overabundant total credit hours. This flies in the face of a two-decade-old recommendation of ASEE that 20% of the curriculum be devoted to these subjects. And it's even a few percentage points less than the current national engineering curriculum average!

Elsewhere in this report, the committee argues the special role of the engineer: ". . . the ultimate success of a chemical engineering enterprise is dependent in large measure on mutual understanding between chemical engineers and nontechnical financial management and business interests." And "[Engineers] should contribute their talents to the community, not only as a means of demonstrating the nature of their professional activities to the public, but also in response to the demand which civic enterprises traditionally make on educated and able citizens."

Might it not be pertinent to ask whether it's possible to seek such a role, if the education of the engineer puts him at marked disadvantage with his nontechnical contemporaries? It is a generally received opinion that the engineer must grope to express his thoughts, either orally or in writing. I suggest that this is only the surface of a deeper problem—that, as the manifestation of awkward intellectual processes, its failure mirrors the deficiencies of illiberal training.

But attention to the problems of engineering education still must center on the technical content of the curriculum. In the report on dynamic objectives, science is evoked throughout. Perhaps this is right—chemical engineering traditionally has been allied closely with the sciences it seeks to place in practice. There is, however, some evidence to support a little braking of the bandwagon.

Such a leader in engineering education as MIT was represented by a faculty member on the AIChE committee. Presumably his views on more generalized, more "scientific" engineering education are partially reflected in the report. But all the professors at MIT aren't equally enthusiastic for the trends toward more science, less engineering. A vigorous debate is going on at that school as to whether its graduates will be able to make things go—the traditional role of the engineer. And a colleague of the MIT panel member rose in the audience, in Washington, to raise the specter of the swing out of engineering and into science, at freshman level.

Recent figures show that nearly 50% of those who initially enroll in engineering drop out somewhere along the way to the degree. Nearly 40% of the dropouts can be attributed to the stronger pull of the sciences. This, of course, a charter member of the committee had qualitatively concluded in observing the engineering science program in his university. And he stated his views a year before the committee on dynamic objectives was formed, at the Golden Jubilee meeting of AIChE (*Chem. Eng.*, Aug. 11, 1958).

Is the trend toward "scientification" of the engineering curriculum going to get us into trouble? If the chemical industry were truly a growth industry, we could absorb and use all the innovators that the universities can produce. But there is recurring evidence that we are in a mature industry, and this means that engineers may find the emphasis of their work subtly changing from R & D to production functions. If this analysis is correct, it implies an increasing need for engineers who can make things go more economically.

To meet the requirements of this situation, the universities may have to re-examine the premises underlying current trends. The argument about form (and reform) of curriculum goes on forever, but I suggest that there is no one best form. Perhaps four-year liberal-scientific undergraduate study, followed by two to three years of graduate study, could provide the engineering leaders—the guides of innovation. And perhaps the traditional four-year course, with ECPD-encouraged variations of emphasis from school to school, can provide a solid body of *engineers*.

In any case, the implications are clear. The educators must rethink their case realistically, and the accreditation groups must examine the disparity between their ideals and the college catalogs to determine which must change.

When Men Are Employed, They Are Best Content

The second major area of concern to today's engineer is the relationship with his employer. No shaping of the profession's mold can fail to consider this as one of the prime influences. The report on dynamic objectives doesn't ignore this area, but I feel that it doesn't come to grips with it either. Although the report says that "in some way" the young engineer must balance various goal demands, it suggests only that he can obtain balance "from an environment which encourages him."

Promotion of such an environment has been largely

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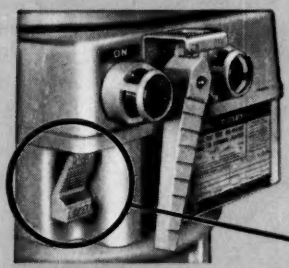

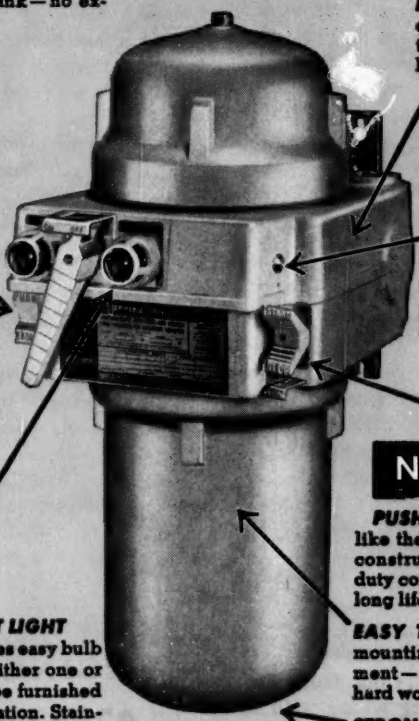

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passive—e.g., the fine booklet on professional standards of the Institute. But there's real opportunity being missed within AIChE to chase the ubiquitous "poor communications" that both engineers and managers claim plague their relationship. It's a fact that AIChE has many influential members and leaders who, once engineers, are now managers. Why not take advantage of the professional forum, for continuing exchanges of opinion and viewpoint toward bettering the employment relationship in general?

Many of the problems that upset the young professional's equilibrium in his job boil down to a difference in values assigned by him and by his managers to professional responsibilities. The report on dynamic objectives, for example, urges continuing self-education as being of paramount importance. Many engineers in industry feel that postcollege study is necessary to building professionalism, and are engaged in such self-help. Few of their managers, however, assign much importance to this, or even know that their engineers are so engaged.

Furthermore, though managers urge that professional employees keep up with company business and economic matters, and that they identify with company goals, they do not know that their engineers actually believe that they are doing so. Other areas of mutual misunderstanding include participation in nonrelated community activities, and discussion of problems of professional status.

Is it any wonder, then, that the young chemical engineer faces a future in professional engineering with some trepidation? He finds that it's hard to learn what is expected of him, how his company does things, what adjustments to company goals are necessary. He must accept routine, unglamorous jobs in which he advances, materially and professionally, at what seems to him a slow pace. Disillusioned by his work setting—a disillusionment that's heightened by the ambiguity of what his managers say and what they do—he turns his career goals to administration, if he can.

And AIChE encourages it. Its leaders, by and large, are managers (and educators) sprung from former engineering work. There's nothing wrong with these men attaining prominence in their companies and in their professional association. In fact, it's perfectly natural. It's just that they don't have the intimate tie to, or viewpoint of, the professional worker. And so the chemical engineer finds the same conflicts of perception in his society as he finds in his employment situation.

Underlying the report on dynamic objectives, for example, is a recurring theme: get out of engineering, get into management. "Since a professional society should continue to provide services for its members *as they progress*, the AIChE must devote more effort to providing more services for the sizable number of chemical engineers who reach a management position." And *"Engineering training is good training for managers* because it teaches an understanding of the interaction of the components of a system and inculcates an appreciation of logical analysis."

Among Friends, All Things Are Common

The third major area of concern, then—that of collective responsibility for professionalism — is tightly interwoven with the employee-employer relationship. Because, if the chemical engineer sees the same problems of ambiguity and divergent goals on the part of society leaders that he sees, oftentime, within his employment situation, then he will not be ready to accept their exhortations about the pathway to professionalism.

The committee has noted, in the report, that less than a third of all chemical engineers become and remain members of AIChE. It might try to get to the root of the problem of not only why people don't join, but why most engineers, who do belong to technical and professional societies, don't feel that such membership is very important to building professionalism. Too, it might question why managers of these same engineers mostly feel that belonging to a society and attending its meetings are very important—again, two viewpoints at variance.

It seems to me, as I ask these questions, that increasing problems face AIChE in its encouragement of professionalism, unless it, too, asks more questions and patiently examines the answers. It's not fair to the profession it wants to represent to issue a final report on dynamic objectives that will be buried quietly, and that will discourage further those young professionals who seek mature, purposeful advice. There's no reason, with its diverse membership, why it can't become as competent in its professional leadership as it unquestionably is in its technical.

But the questions must be asked, the answers sought.

ENGINEERING JOBS NOT AT STAKE RIGHT NOW

Last month, *CE* reported on the nationwide job prospects for chemical engineers (*Chem. Eng.*, Feb. 20, p. 73). To see a little better how the economy is affecting engineering employment, let's examine the regional reports to *CE* a little closer.

From the East Coast—Though only fair, the New York market is a far cry from 1958's "critical" situation. Many engineers involved in cutbacks have found jobs in other CPI firms—in some cases, within other divisions of the same company that cut them.

In Atlanta, the pulp and paper industry is hiring. Chemical firms, too, find little need for cutbacks. Georgia Tech's placement office says there's a shortage of chemical engineers in the area.

From the Industrial Middle—Two major CPI employers in Cleveland are continuing recruiting efforts,

Problem: Exhaust hoods that don't exhaust

This plant needs make-up air! If the exhaust hoods in your plant aren't doing their full job, chances are they are being outpulled by other fans. Other exhaust fans set up a vacuum by removing air faster than you replace it. Your plant needs make-up air...a supply of new air to replace exhausted air.

Without sufficient make-up air, exhaust hoods can't do their job properly. Plant air becomes contaminated with fumes, dust, and odors. Workers' health suffers. Absenteeism rises; production lags. Other vacuum problems crop up: hot spots at inside areas, cold drafts along walls.

Solution: install a make-up air system -- fans to bring in outside air, and heaters to temper it. A make-up air system like this cancels out vacuum, gives balanced heat and ventilation.

For technical help on make-up air, see your Consulting Engineer. Or call in Sturtevant application engineers. They're experts in handling air...whether you want to move it, heat, cool or clean it. J-80711

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aren't laying off. Many of the 600-700 engineers laid off in 1958 migrated to West Coast aerospace firms. This time, that's not happening.

Detroit reported unemployment of chemical engineers was at a low in state, with no anticipated layoffs. But Chicago, though without many jobless engineers, seems to have lowered its demand for chemical engineers particularly. No one calls it a major trend.

From the Southwest—With the Ship Channel building boom, Houston editor Tom Arnold reports no engineers are being laid off, and young chemical engineers are in short supply. Dallas, not to be outdone, claims employment is in better shape than anywhere else in Texas. CPI firms there are still hiring.

From the West Coast—In the Bay area, ChE's, like most everyone else, seem content: no layoffs, few looking for new jobs. And though the Los Angeles job market is tight, chemical engineers seem relatively secure. Seattle echoes the cautious optimism.

Summing up, then: though the ChE job market appears to have tightened up a little, no major dislocations have appeared. Too, firms are still looking for youngsters. At the same time, more emphasis is being given to merit pay rises.

EJC SALARY STUDY SHOWS PAY GAINS

Engineers Joint Council, through its Engineering Manpower Commission, has released its fourth biennial salary survey. Last one, covering 1958 (*Chem. Eng.*, Mar. 23, 1959, pp. 188-192), showed engineers in the chemical industry doing better than other-industry colleagues. Latest one,* covering 1960, confirms this, but continues some misleading reporting.

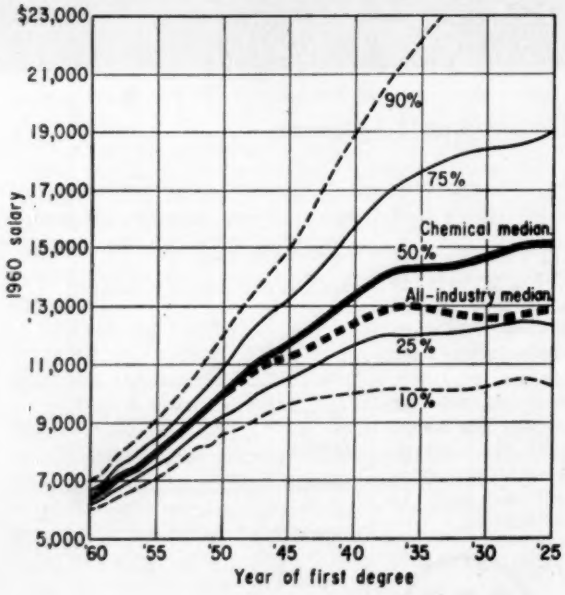
Over-all median salary pushed up to $9,600 from $8,750 in 1958. Median years of experience of the 190,840 engineers with degrees was 9.8—no change from 1958. Chart at left below shows that chemical median salary levels follow the all-industry median up to the over-all salary and experience median point. From then on, the chemical curve breaks higher. (Curves show top of given percentile.)

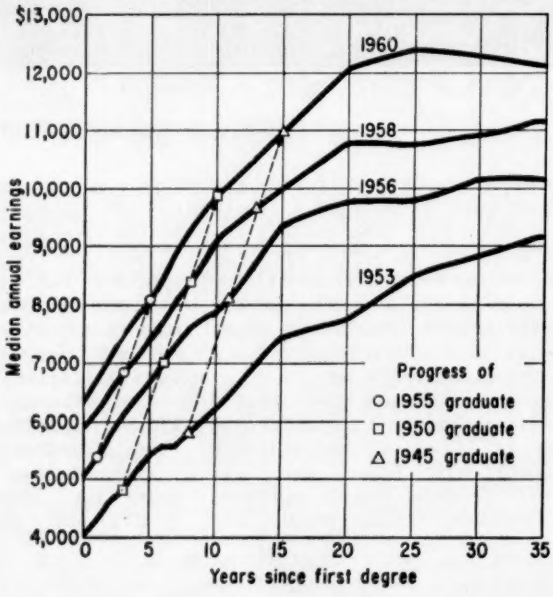
The EMC report is deceptive in a couple of ways. Statements of percentage gain are made in terms of simple interest, rather than of the more-realistic compound interest. You use the latter when you decide if the 10% pay rise you just got is enough.

And merit proved is not necessarily merit paid. The 1958 median graduate, for example, started at $4,050, now makes $8,900—a 11% growth compounded over the seven years of work. The median starting engineer in 1960, though, earned $6,300. Difference between his salary and that of the 1953 grad is equivalent to a 5% growth over a seven-year period—that portion of the 11% apparent growth that can be attributed to merit. The other 6% represents parity with inflated starting salaries. Shown in the chart at right below is median earnings progress.

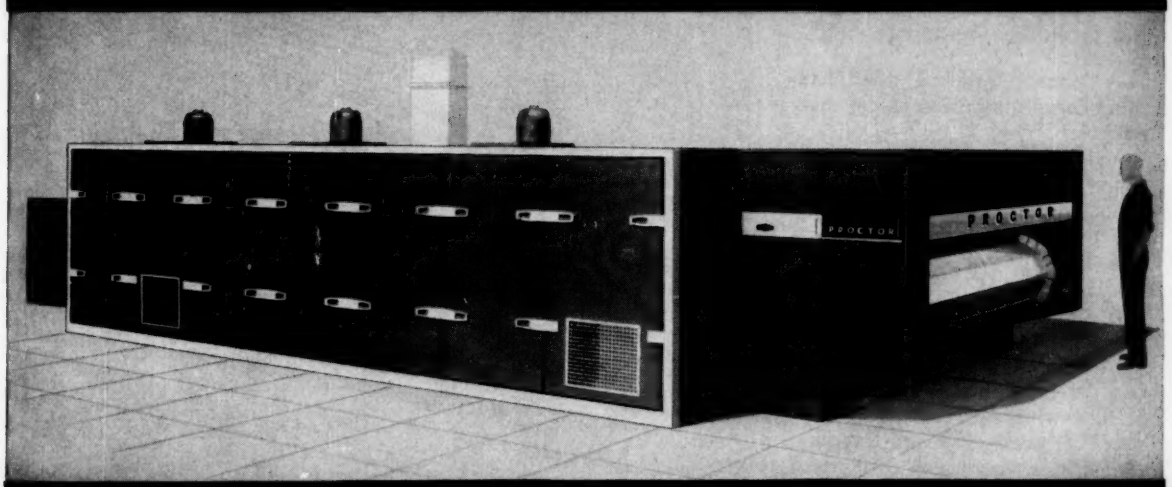
* Available from EMC, 29 W. 39th St., New York 18, N. Y., at $3/ copy.

Some data from EJC pay study: chemical industry (left), all-industry trends (right)





all-new



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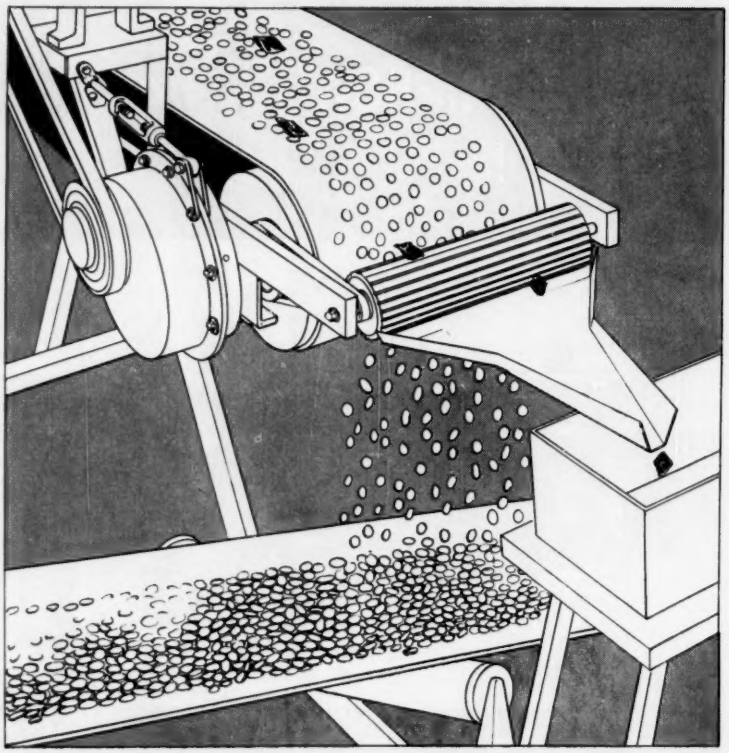

A common problem when handling large quantities of dry bulk material stored in bins or piles is to date and identify the portion of the pile being used at a given time. This problem is easily overcome if the out-of-storage conveying system contains an effective tramp iron magnet.

At the time the material is placed in the pile or bin, a suitable number of iron tags can be included at intervals. These tags would be inscribed with such information as date of manufacture or receipt, composition, process operating conditions, etc. Alternatively, a plastic capsule containing a dated or coded slip of paper together with a small piece of iron, such as a nail, can be used.

As the material is conveyed from the pile, these tags are retrieved at convenient intervals from the magnet, allowing more refined control of process conditions, inventory and quality.

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Reduce Dust Escape by Balancing Pressure

By E. M. Cook

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Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant Notebook Editor, *Chemical Engineering*, 330 W. 42 St., New York 36.

ESTIMATE WATER OF SATURATION

RAMON OLIU
*Foster Wheeler Corp., New York**

The water of saturation carried by gases at a given set of conditions can be estimated quickly and with a fair degree of accuracy by the chart reproduced on the following page.

The chart was constructed assuming ideal gas behavior and I have found it useful in synthesis gas process calculations. Under the operating conditions of synthesis gas plants, the gas stream, composed mainly of H_2, CO and CO_2, follows very closely the ideal gas law. Furthermore, the effect of pressure on the vapor pressure of water is small for this system. The deviations are within the order of the accuracy attained in the construction of the chart.

An example will illustrate the use

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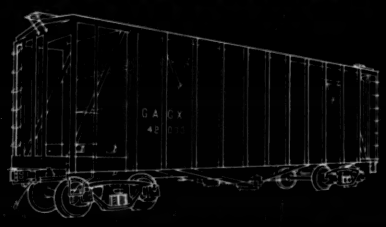
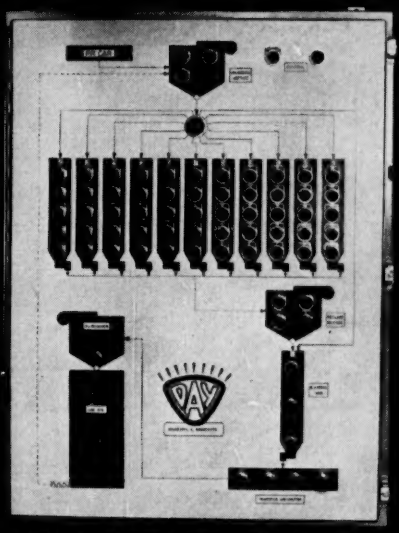
High density pneumatic conveying system for unloading polyethylene pellets from railcar. After piping connections are made, dual-purpose DAY "RJ" receiver, shown right in photo, "pulls" product from railcar and "pushes" it to storage tanks or manufacturing process.

PUSH A BUTTON

START

UNLOAD A RAILCAR





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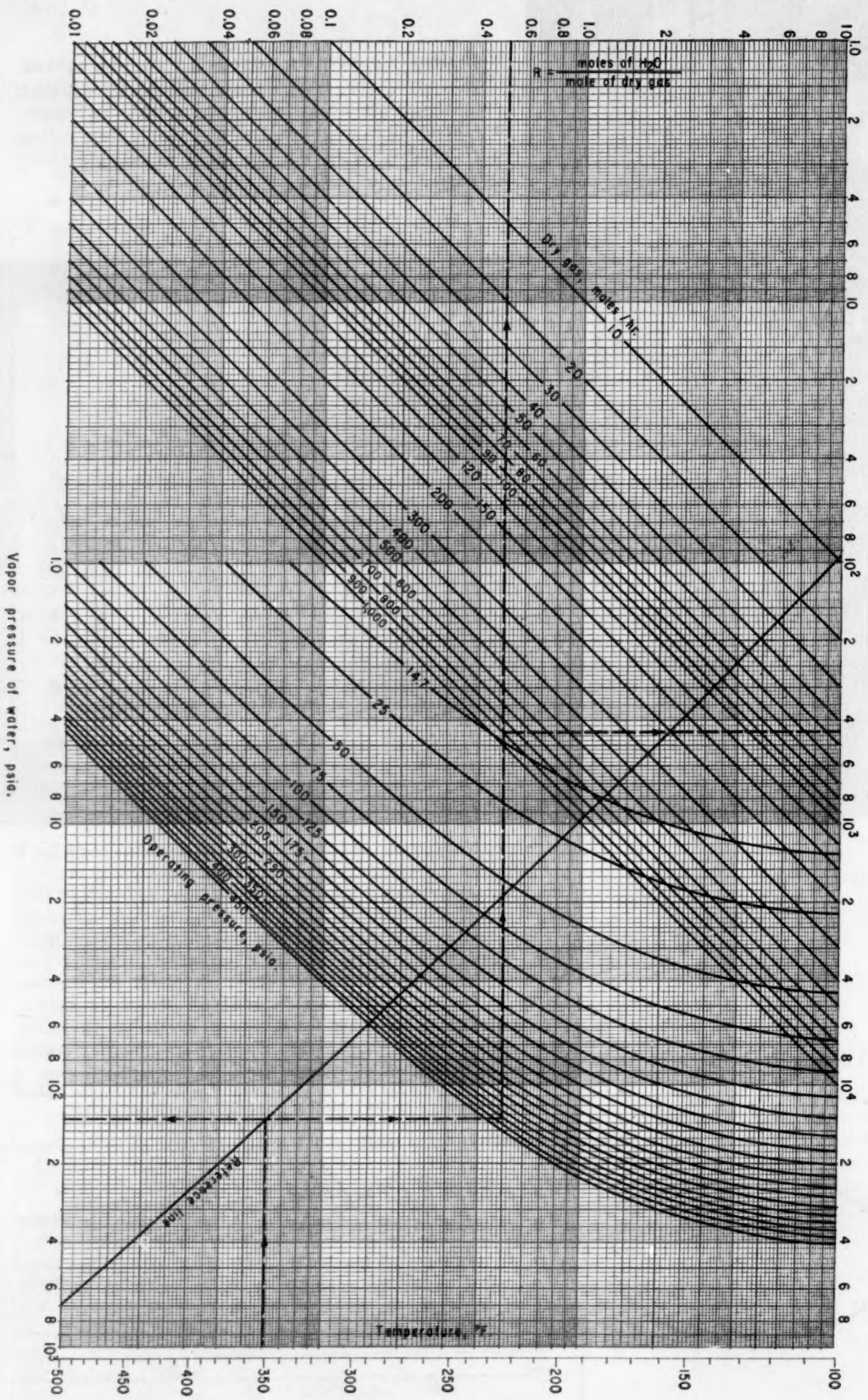
R = moles of H2O / mole of dry gas
Dry gas, moles/hr.
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20
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900
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1417
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50
75
100
125
150
175
200
225
250
300
350
400
Operating pressure, psig.
Reference line
Temperature, °F.
Vapor pressure of water, psia.
H2O, moles / hr.

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of the chart. To determine the water of saturation carried by 900 moles/hr. of dry gas at 350 F. and 400 psia.:

1. Enter the temperature scale, at right, at 350 F. and move horizontally to the reference line.
2. Proceed vertically to the pressure curve at 400 psia.
3. Move to the left horizontally to dry gas line of 900 moles/hr.
4. Proceed vertically to read 450 moles/hr. water of saturation on the upper scale.

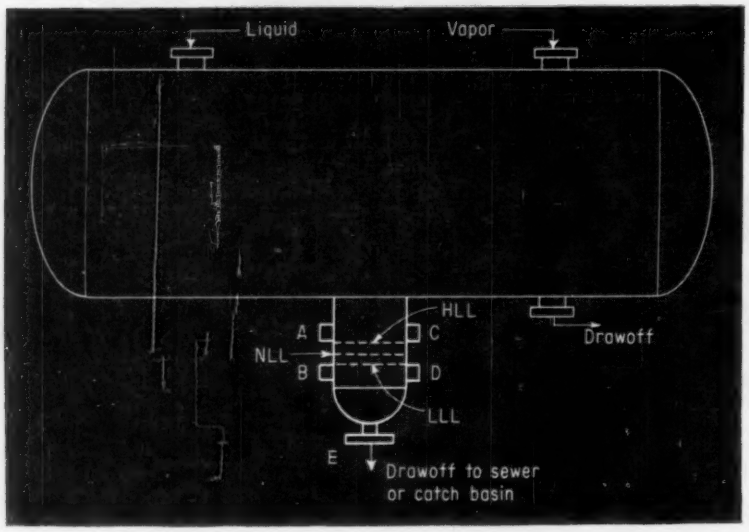
The comparable result by calculation is 457 moles/hr. The lower scale gives vapor pressure of water (136 psia. vs. 134.6 psia. by steam tables). The scale at left gives the humidity of the gas in moles/mole.

Test Your CEQ

By ROBERT LEMLICH

An orifice meter (with a manometer containing mercury) and a rotameter are connected in series to measure simultaneously the flow rate of turbulently flowing water. The specific gravity of the rotameter float is 7.5. When this float is balanced at a certain level, the orifice manometer difference is 200 mm. Now if, instead of water, the system were to carry a turbulently flowing solvent with a specific gravity of 0.8, what would the manometer read if the rotameter float were again balanced at that particular level?

(*Answer on page* 180)



REFLUX DRUM DESIGN–CASE 3

S. H. FRIEDMAN, J. W. MURTHA
Bechtel Associates, New York

This is another in a series of process-design notes that present empirical methods developed from the authors' experience. This article considers the third and last case for the design of a distillation reflux drum—water, but no vapor, present in the column overhead. The other cases were covered in two previous articles (*Chem. Eng.*, Nov. 14, 1960, p. 235 and Jan. 23, 1961, p. 157).

Once again, the drum diameter is determined as in the first of the two articles mentioned above.

Water is removed from the hydrocarbon by settling in a cylindrical pot or boot attached to the bottom of the drum, see sketch. Theoretically, the size of the boot should be determined by the settling time but actually it is set empirically. The design criteria are as follows:

Holdup between LLL and NLL should be equivalent to 1 min. of flow.

For a flow rate of 0.1 ft./sec., use a minimum boot size of 12 in.

For 12 in. and larger sizes, specify the boot as pipe, letting the drum pressure establish the pipe schedule.

Usually, the boot length should be 2-3 ft.

The boot drawoff should go to waste or a special sewer.

In selecting boot length, remember that the minimum instrument level range is 14 in. This corresponds roughly to the distance between LLL and HLL (interface).

Nozzle duties, referring to the sketch, are as follows:

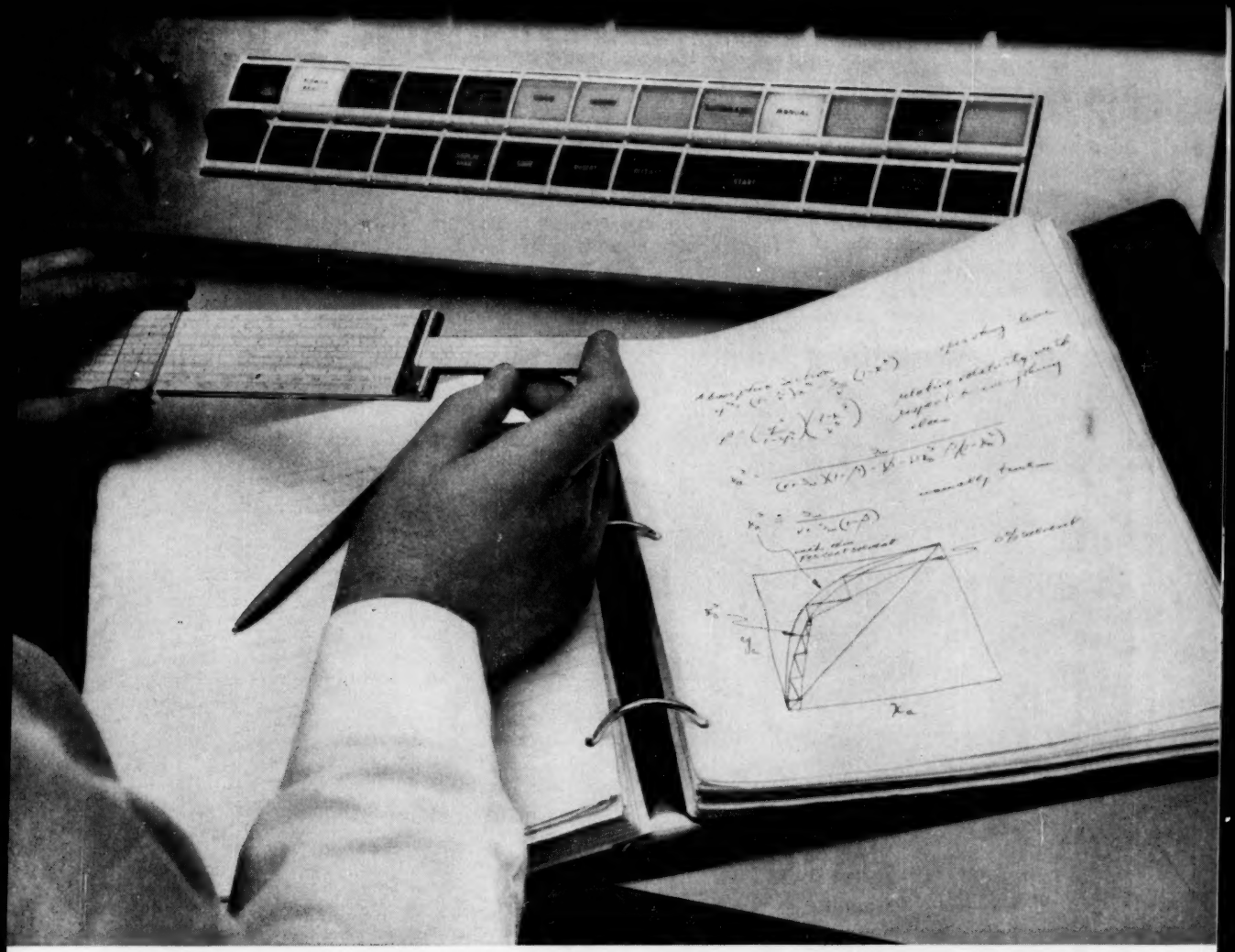
A and *B* are level controller connections; *C* and *D* are gage glass connections; *E* is the drawoff connection.

Use This Simple Organic Chemistry Shorthand

ROBERT LEMLICH
University of Cincinnati

There is an obscure method of organic chemistry shorthand that deserves wider publicity. It allows the writing of complete structural formulas with a few strokes of the pen. The principle is not new with me. Unfortunately, I cannot recall who it was years ago who suggested it.

The basis of the method is the representation of the atoms in a molecule in terms of their respective valences. A junction of four lines represents carbon, three or five lines nitrogen and two lines oxygen. The free end of a line (a



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***Here's what the Unit Operations Simulator does for you: 1.** Computation of equilibrium constant. **2.** Computation of temperature from a given equilibrium constant. **3.** Computation of enthalpy of a vapor and/or liquid stream. **4.** Find equilibrium constant nearest unit. **5.** Computation of temperature from a given enthalpy of a vapor and/or liquid stream. **6.** Bubble point and dew point calculations. **7.** Split one stream into two at specified ratio. **8.** Mix two streams of same phase. **9.** A mixed feed adiabatic flash calculation. **10.** Adiabatic flash. **11.** Isothermal flash. **12.** Flash to a specified quantity of vapor. **13.** Absorber/stripper calculation using Edmister short cut.

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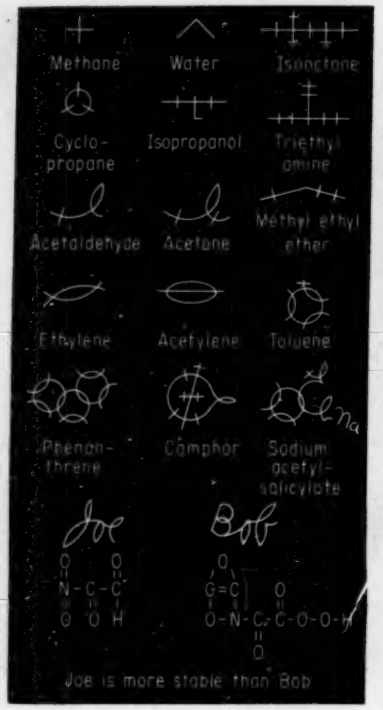
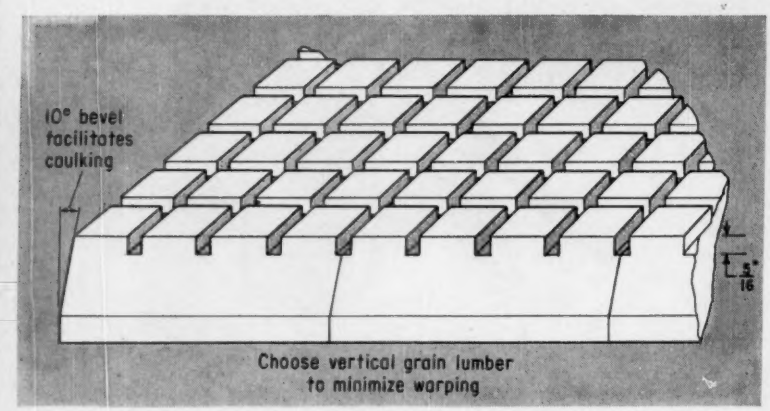
junction of one line so to speak) represents hydrogen. Thus, the first symbol in the figure is methane. An atom of carbon is at the junction of the four lines and an atom of hydrogen is at each free end. Similarly, alcohols, amines, aldehydes and other classes of compounds can be readily represented.

For compounds with multiple bonds, both straight chain and ring, the lines are merely curved. Thus, the structural formula of just about any compound of C, N, O and H can be shown by sketching these lines. The letter symbols for these four need not be shown—only where another element appears in the letter symbol required.

With a little familiarity, both facility and speed in this simple method of chemical shorthand can be attained. In addition, the technique is almost fun to use.





Emergency Filter-Cloth Support Made of Wood

R. E. LEONARD
American Potash and Chemical Corp

We had been using porous silica block as a filter-cloth support on an 8-sq. ft. vacuum Nutsche filter. Occasional breakage of the blocks had not been a problem until a sudden sequence of such events left us with no replacements late one Friday afternoon—quitting time for all except pilot-plant personnel. The acidity of the thick slurry we were filtering necessitated a corrosion-resistant support.

Our carpenter fastened four lengths of 2-in. × 6-in. Douglas fir together with two hardwood dowels. Then, using the table saw, he cut a crisscross pattern of saw kerfs on 1-in. centers, into the top surface.

Drainage holes were drilled at every fifth intersection and the outer edges of the assembly were beveled to facilitate caulking of the filter cloth with asbestos rope. The result, completed in about 2 hr., was a grid similar to the plate seen in some plate-and-frame filters.

The support lasted through the weekend and 3 mo. later was still in good condition. A thick filter cake and thick cloth apparently allowed enough transverse flow of filtrate so that the large flat peaks of the grid did not materially reduce flow rates.

Answer to Test Your CEQ

For a particular orifice meter, the usual orifice equation reduces to

$$W \propto \sqrt{\rho\,(\Delta P)} \qquad (1)$$

where W is the flow rate in mass per unit time, ρ is the fluid density and ΔP is the pressure drop across the manometer taps. For the mercury-filled manometer, however,

$$\Delta P \propto R\,(\rho_{Hg} - \rho) \qquad (2)$$

where R is the manometer reading. Combining (1) and (2) yields

$$W \propto \sqrt{R\rho\,(\rho_{Hg} - \rho)} \qquad (3)$$

Now, for a rotameter with its float balanced at a certain location, the usual rotameter equation simplifies in our case to

$$W \propto \sqrt{\rho(\rho_f - \rho)} \qquad (4)$$

where ρ_f is the float density. Combining (3) and (4) gives

$$\sqrt{R\rho\,(\rho_{Hg}-\rho)} \propto \sqrt{\rho\,(\rho_f-\rho)} \qquad (5)$$

or

$$\frac{[R\rho\,(\rho_{Hg}-\rho)]_s}{[R\rho\,(\rho_{Hg}-\rho)]_w} = \frac{[\rho\,(\rho_f-\rho)]_s}{[\rho\,(\rho_f-\rho)]_w} \qquad (6)$$

where subscript S refers to the solvent and W to the water. Eq. 6 can be simplified somewhat.

$$\frac{[R\,(\rho_{Hg}-\rho)]_s}{[R\,(\rho_{Hg}-\rho)]_w} = \frac{(\rho_f-\rho)_s}{(\rho_f-\rho)_w} \qquad (7)$$

Substituting in Eq. 7,

$$\frac{R_s\,(13.6-0.8)}{200\,(13.6-1)} = \frac{7.5-0.8}{7.5-1} \qquad (8)$$

Solving for the manometer reading R, yields 203 mm.

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No. 50: Cost-Capacity Data IV

These three pages of graphs constitute the final installment in our present series showing the exponential relationship of cost versus capacity in chemical plant construction.

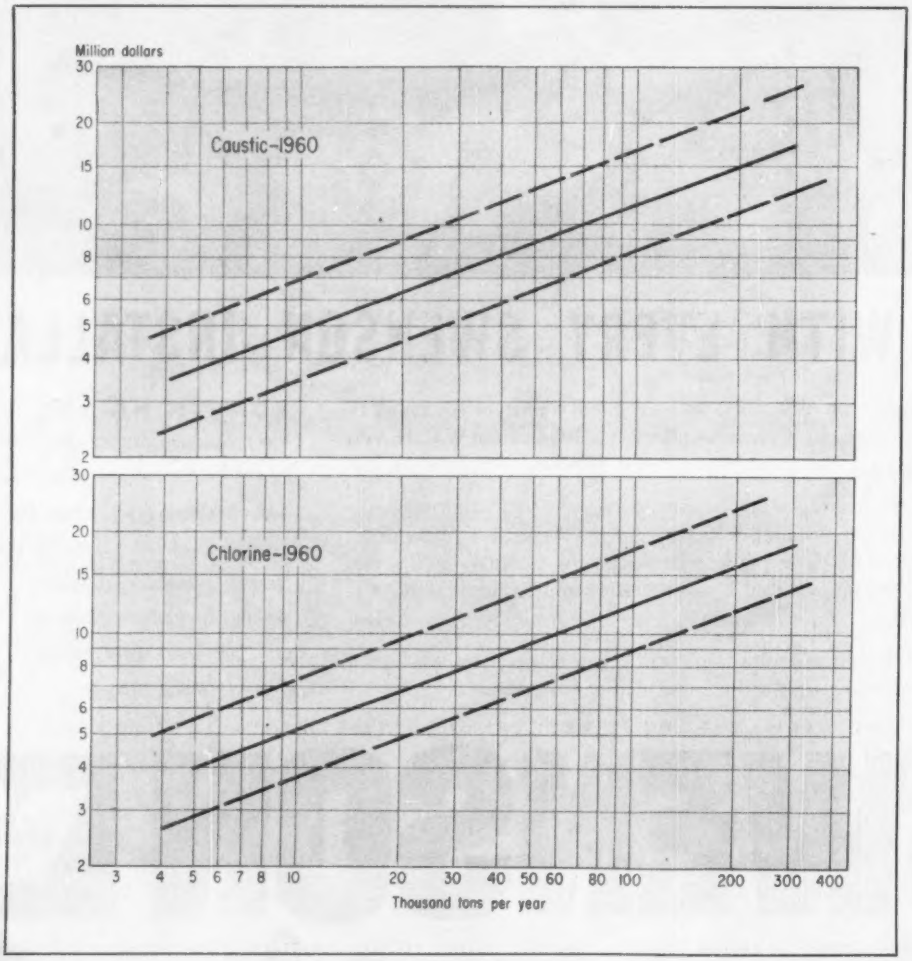
JONAS M. BERK,* JOHN E. HASELBARTH
Pritchard and Abbott, Houston, Tex.

This is the last installment of Cost/Capacity data in this series. Previous data appeared in Cost File No. 46 (Dec. 12, 1960, p. 172), No. 48 (Jan. 23, 1961) and No. 49 (Feb. 20, 1961, p. 174).

Capacity exponential factors (also called "power" factors, see *Chem. Eng.*, Mar. 7, 1960, p. 116) for the graphed processes are: caustic, 0.38; chlorine, 0.38; sulfuric acid, 0.90; hydrogen cyanide, 0.82; ammonia, 0.88; butadiene, 0.65. Data are for the first quarter of 1960.

For both caustic and chlorine plants, there were enough data to show costs for the three categories of construction described in Cost File 29 (Apr. 18, 1960). The categories are an entirely new "grass roots" plant, a new unit built within a developed plant site and an enlargement of an existing unit.

* Mr. Berk is currently with Industrial Appraisal Engineers, Houston, Tex.



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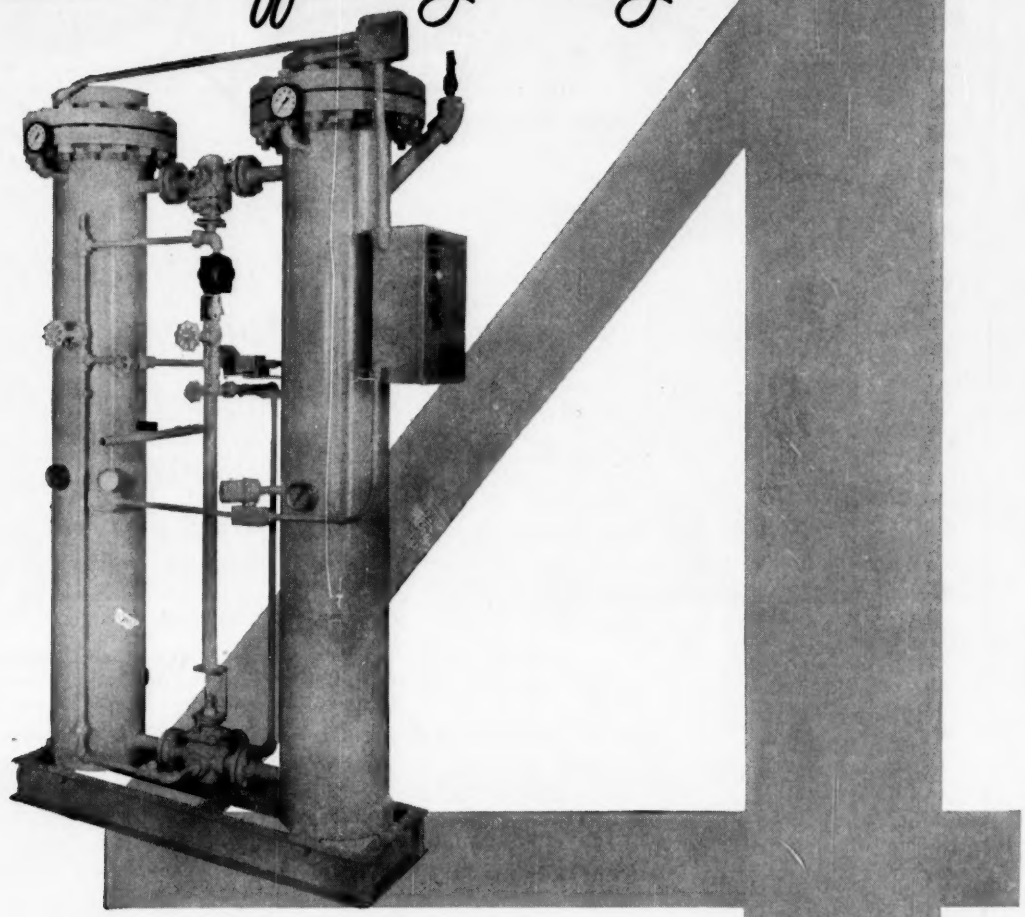

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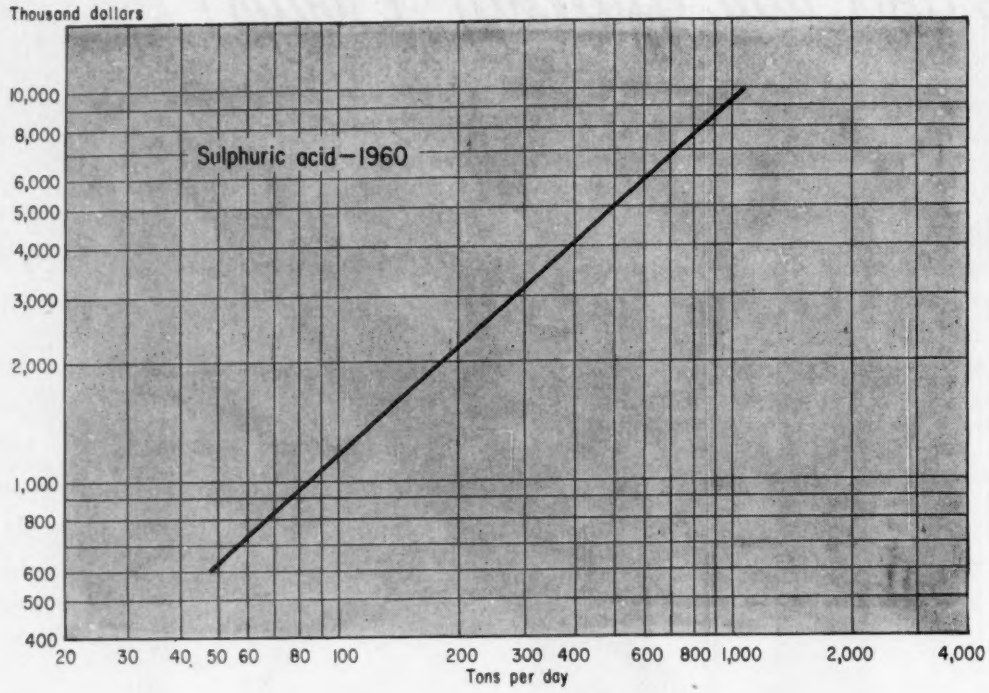
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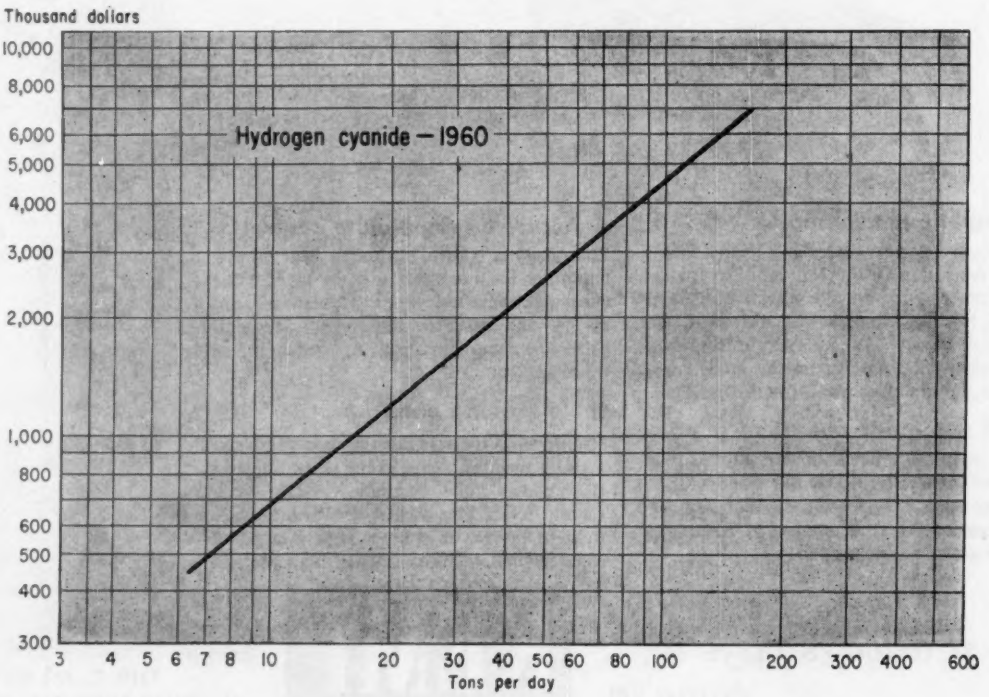
Tons per day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600
Tons per day

What the affiliation of Rochester Manufacturing Co. with American-Standard® means to you

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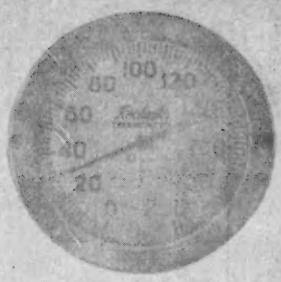

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Rochester Pressure Gauges

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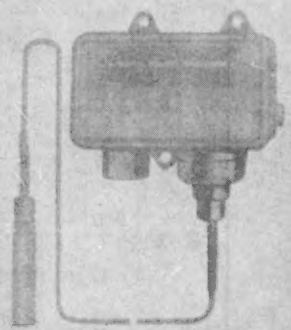
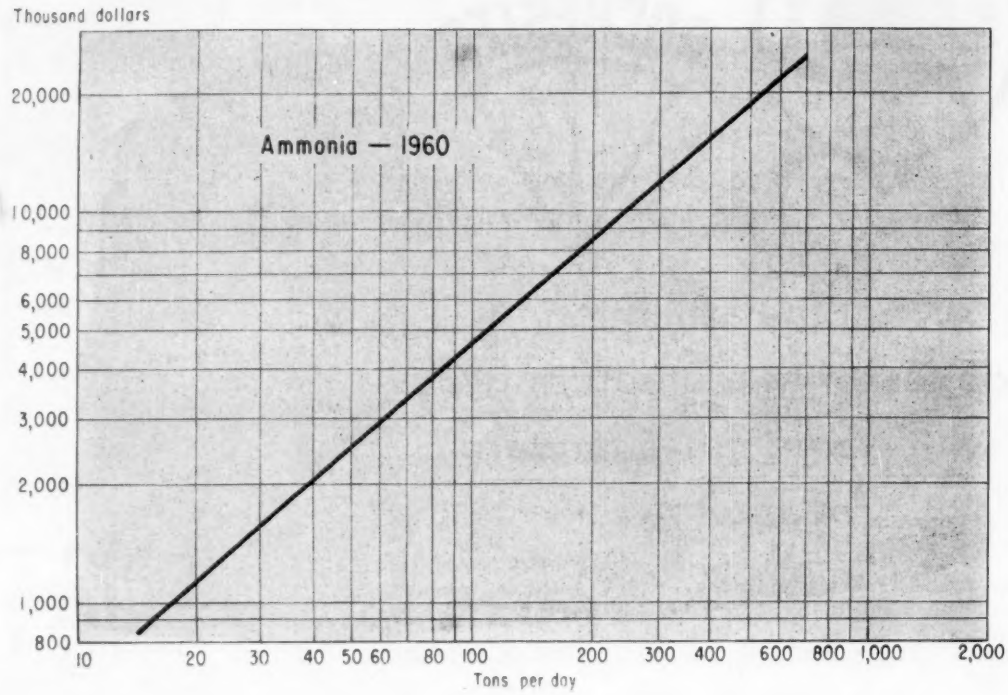


DETROIT Pressure Control Switch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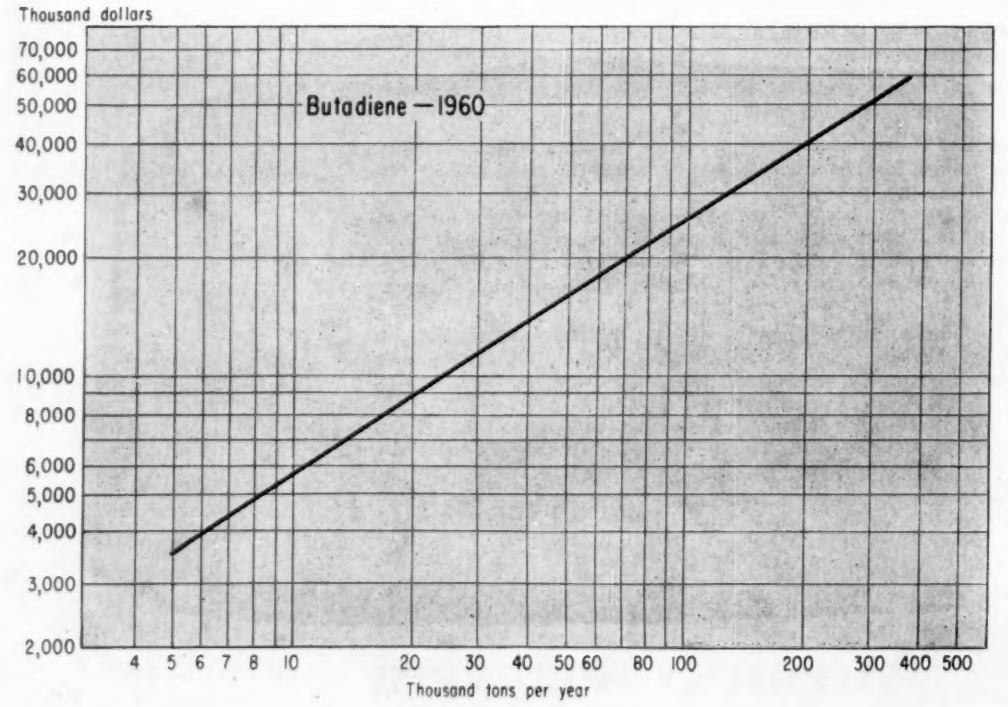
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Butadiene — 1960
4
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80
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200
300
400
500
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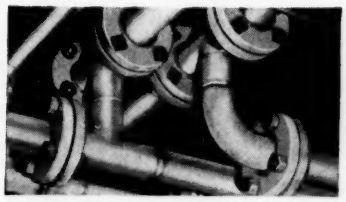

The ultimate installed cost of corrosion-resistant process lines *can* be substantially reduced . . . where pipe line design specifications take full advantage of up-to-date developments in improved fittings design and new piping standards.

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Chromizing Turns Steel Into "Stainless"

Chromium-diffusion technology takes a big step forward with coming availability of large, treated steel plates and sheets. "Chromizing," involving building up a chromium-rich layer on steel, has been limited until now to small parts. A big advantage: treated plates are cheaper than solid or clad stainless.

A novel method for building a stainless layer on carbon steel may have significant implications for process plants. The method: chromium diffusion. Big advantage: a product much cheaper than solid stainless or stainless clad.

One major steel producer, using the process, is already turning out research quantities of chromium-treated steel plates.

▶Newcomer Claims — Chromium-diffusion techniques have been available for over 50 yr. in this country and in Europe. But they've stirred up little enthusiasm among chemical engineers: most methods can only handle small parts such as pump impellers, turbine blades, heating elements.

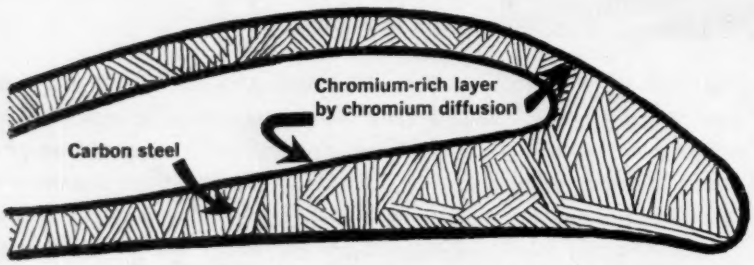
However, a relative newcomer, Alloy Surfaces Co., Wilmington, Del., claims its new Alphatizing process is capable of treating large plates and sheets and, eventually, fabricated vessels. Lukens Steel, using Alloy Surfaces' technique, has on a research and development basis chromized 4-ft. x 8-ft. steel plates without difficulty and Lukens research engineers see no reason why large-sized dished heads couldn't be treated.

The steel plates, in effect, have a chromium-rich layer on both sides. This layer is not a coating—it's an alloy metallurgically changing the steel surface. And it has many of the properties of a Type 430 stainless steel. Plates can be joined by standard welding techniques to make chemical equipment.

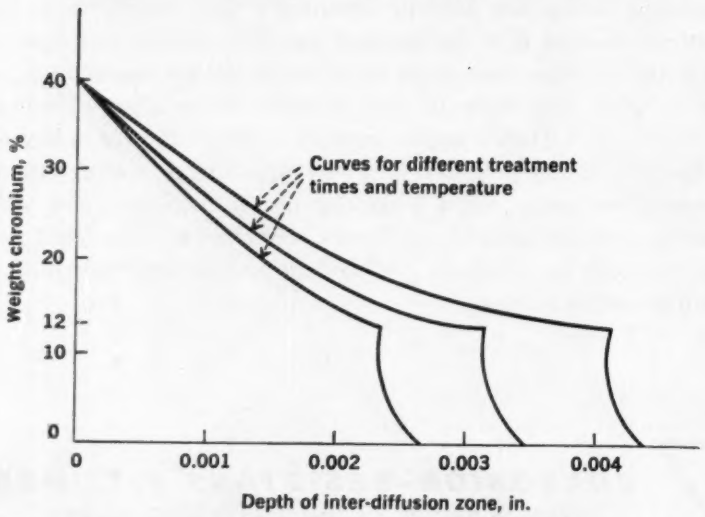
Basically, the Alloy Surfaces process is very similar to other techniques used in this country—they all operate on the same principal. Chromium is released from some compound as a gas. Gaseous chromium displaces iron from the steel (iron is picked up by the carrier gas), chromium diffuses into the steel forming an alloy and also combining with carbon. Depth of the alloy depends on treatment temperature, time, quality of steel, and is usually in the 0.001 to 0.005-in. range.

▶Many Variations—There are numerous variations on this basic procedure. A powder-pack method, used by one of the pioneers in this field, Chromalloy Corp., White Plains, N. Y., involves packing a powder around pieces to be treated in a furnace. The powder contains a chromium-halide compound, a refractory diluent such as clay, sand or ceramic, and an "energizer" that helps to purge the furnace of air. Metal and powder are heated to 1,650 to 2,000 F. One essential requirement of this process: parts must be in intimate contact with the powder before any diffusion takes place.

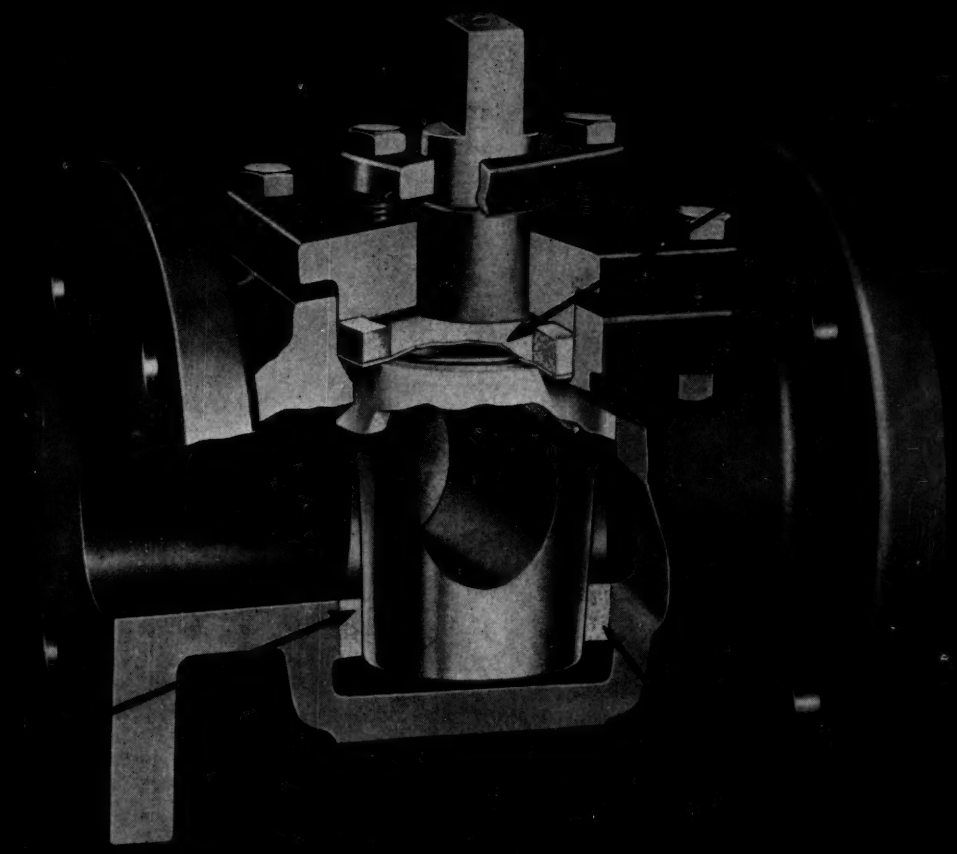
Haynes Stellite Co., div. of Union Carbide, has also recently



Chromium diffusion displaces iron in steel



Depth of the diffused zone depends on treatment time and temperature. The inflection point, at about 12% chromium, corresponds to the amount of chromium that transforms austenite to alpha iron. Rate of diffusion of chromium in austenite is much slower than in ferrite. Steel is AISI 1008.



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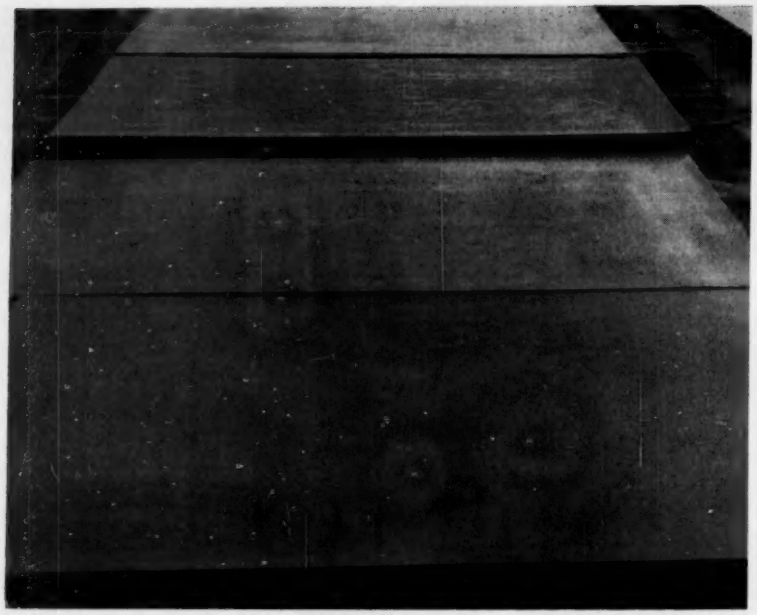


Large steel plates, sheets, dished heads can now be treated by chromium-diffusion, building up stainless layer. Treated plates above are 4-ft. x 8-ft.

stepped into the field with a diffusion coating. The emphasis here is on treating high-temperature nickel- and cobalt-based alloys to improve oxidation resistance at temperatures of 2,300 F. And while the claim is "no limitation on the size of parts that can be coated," treating equipment limits sizes to 15-in. x 16-in. x 18-in. maximum.

▶ **Alloy Surfaces Process** — Alloy Surfaces seems to have come up with something slightly different from powder packing. The process material is a granular chromium alloy which contains a controlled amount of a chromium halide.

This compound, which is sold to licensees of the process, releases a constant amount of chromium over the life of material when heated to 1,650-2,000 F. This is a vital point since one of the important controls involves keeping a constant supply of chromium on the surface of the steel.

Another key point in the Alloy Surfaces process is that no inert materials are needed, and parts do not have to come into contact with the compound (although in most cases a loose pack is used). The result is a minimum of treatment space, and large pieces can be chromized in standard heat-treating furnaces. Actually, the process is a close relative to gas-nitriding or gas-carburizing techniques.

After treatment, steel is usually rinsed in water and the treatment compound re-used. Parts can be core-hardened by quenching in oil.

Raising the treatment temperature usually accelerates the operation, but this advantage must be weighed against possible grain growth and distortion of the steel.

▶ **Carbon Is Important** — Characteristics of chromized steel depend mainly on the steel being processed. Carbon content has a great effect since carbon strongly retards chromium diffusion. So, for a stainless surface, a low-carbon (less than 0.1%) or carbon-stabilized steel must be selected. A low-carbon, light-gage steel (14-20 gage) can easily have a chromium-rich layer (called case) of 0.001 to 0.01-in. thick. The same applies to stabilized, low-carbon steel in any gage. Medium- and high-carbon steels develop depths of about 0.002-in. maximum.

Case hardness increases with carbon content and section thickness. For instance, high-carbon steels form complex chromium carbides and shallow, hard cases (76 Rockwell C).

Surface chromium content of chromized steels runs in excess of 40%, decreasing to about 12% (*see curves, p.* 188) in the interior.

Low-carbon and stabilized-carbon steels less than ⅛-in. thick have a ductile case. And weldability of this case is excellent—spot or seam welding does not disrupt case continuity, nor does arc welding with a stainless rod. Flash-butt welding is not recommended.

The ductile case material can be formed fairly easily. On sheet metal, right angle bends will not

Compare costs of chromized steel and stainless

	Cost, $/Lb. of Steel						
	Sheet, Gage				Plate, In.†		
	20	18	16	14	1/4	3/8	1/2
Mild steel	0.080	0.080	0.080	0.080	0.120	0.120	0.120
Alphatizing process cost*	0.167	0.125	0.100	0.080	0.047	0.031	0.023
Total costs, Alphatized mild steel (both sides)	0.247	0.205	0.180	0.160	0.167	0.151	0.143
Type 430 stainless	0.41	0.41	0.41	0.41	0.31	0.31	0.31
Type 430, 10% clad (one side)	—	—	—	—	0.24	0.24	0.24
Type 304 stainless	0.55	0.55	0.55	0.55	0.46	0.46	0.46
Type 304, 10% clad (one side)	—	—	—	—	0.29	0.29	0.29

* Costs include 200% overhead on direct labor, on a case depth of 0.0025 in. on sheet, 0.005 in. on plate. Material costs for treatment powder is 0.78¢/lb. Source for costs is Alloy Surface Co.
† Base-mill for special alloyed, low-carbon steel plate.

BONDSTRAND®

THE "PROBLEM-SOLVER" PIPE

Bondstrand is no ordinary plastic pipe: Made of tension-wound glass filaments, impregnated with chemical-resistant resin—either epoxy or polyester—it is strong as steel . . . yet only one-eighth the weight.

THE PROBLEM	THE LOCATION	THE SOLUTION
Carbon black slurry destroyed schedule 40 steel pipe in 30 days	Synthetic Rubber Plant	Bondstrand installed 1959. No failure. Performance still rated excellent
Chlorine Dioxide water caused failure in stainless steel pipe	Paper Plant	Bondstrand installed 1958. Performance still rated excellent
10% Ferric Chloride solution destroyed ordinary steel or stainless	Sewage Treatment Plant	Bondstrand installed 1958. Performance still rated excellent
Salt water well injection at 1600 psi	Petroleum Production	Bondstrand installed 1958. No failure. Performance still rated excellent

Bondstrand's total installed cost can be actually competitive with ordinary carbon steel pipe. Write for bulletin containing physical and design data.

132

Amercoat® CORPORATION

Dept. AO, 4809 Firestone Blvd., South Gate, California

921 Pitner Ave., Evanston, Ill. • 360 Carnegie Ave., Kenilworth, N.J. • 111 Colgate, Buffalo, N.Y. • 2404 Dennis St., Jacksonville, Fla. • 6530 Supply Row, Houston, Tex.

break it. Treated steel plate can be bent 180° over a ¾-in. radius without case breakdown (up to ¾-in thickness).

▶**Stainless Layer**—From a corrosion standpoint, chromized low-carbon steels resemble Type 400 series stainless. However, chromium content varies through the case. The outermost surface is similar to Type 446 stainless; at the end of the case, a composition similar to Type 410 is present. So, any slight erosion or abrasion exposes a lower grade alloy to the corrosive environment. On the other hand, the case is not porous and will not spall or peel—definite possibilities with sprayed, dipped or plated coatings.

▶**Heat Resistant**—One of the most valuable properties of chromized steel is excellent resistance of the surface to heat. Treated steels can take up to 1,500 F. for at least 1,000 hr. At 1,200 F., life is practically unlimited.

Of course, while building up the chromium layer on the steel core, some changes take place in the core itself. Low-carbon steel will have an annealed and decarburized structure, so aluminum-killed steel is much preferred over rimmed steels, to keep grain growth down during the treatment process. Dimensional changes in low-carbon steels are usually due to grain-size growth, and equal about ½ the case depth on both sides. On medium- and high-carbon steels, growth is about ¾ case depth.

▶**Oranges and Apples**—From a cost standpoint, chromized steel compares very favorably with solid stainless and clad (*see* p. 190). Alloy Surfaces, recently purchased by Reeves Soundcraft Corp., estimates that cost of the treatment material called Alphalloy, is about 2¢/mil thickness of case/sq. ft. area. Process is called Alphatizing.

However, many experts agree that a cost comparison against stainless, solid or clad, is somewhat like comparing oranges with apples. Chromized steel is not stainless steel—at best there is only a relatively thin layer of stainless. Chromized low-carbon steel, therefore, cannot be used in abrasive or corrosive service, where this layer would be removed. The treated steel is protected on both sides, while clad is usually only on one side. But clad plate has a much thicker stainless layer. Cladding permits use of chromium-nickel stainless steels—the most resistant for chemical service (nickel diffusion processes don't exist).

Just where chromium-treated equipment will fit into chemical processes is a question still looking for answers. Certainly, chromium-treated steel has been successful in a long list of applications including turbine blades, strip-heater elements, valves, burner nozzles, car mufflers. The obvious area for chemical applications, at least for low-carbon chromized steel, would be in equipment for high-temperature service; for the hard, medium- and high-carbon steels, in wear-resistant applications.

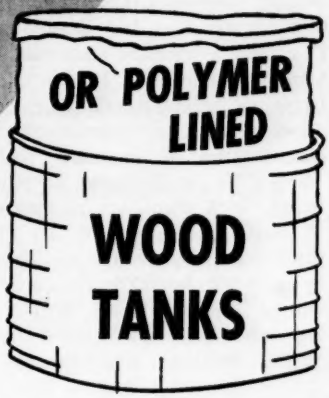
▶**Russian Developments** — Work on diffusion techniques is not limited to this country. A Russian metallurgical authority, N. S. Gorbunov, claims that the diffusion-coating method is the most promising solution to problems of protecting steel surfaces from oxidation at high temperatures.

The Russians are working on multicomponent diffusion coatings, particularly building up layers of silicon and chromium. But single-component coatings are widely used in many Russian industries for protecting a low-cost base metal. Zinc diffusion coatings are used for protecting electrical equipment; aluminum diffusions in refinery equipment; chromium in power, chemical and oil plants. Plating, by comparison, produces a much weaker bond between base metal and coating, confirming work done in this country.

Flux permits joining magnesium to stainless

A recently developed flux makes it possible to join magnesium alloys to stainless steel. Developed by the British Oxygen Co., Ltd., London, S.W.1, England, the new compound, called Tinflux, permits gas welding of an aluminum-beryllium-iron alloy of magnesium to stainless steel. One application: welding of magnesium bushings to stainless bolt stems. These units are used to hold canisters containing radioactive material operating in an atomic pile.

WHY PUT UP WITH . . .



WENDNAGEL

WOOD TANKS FOR CHEMICAL PROCESSING AND STORAGE

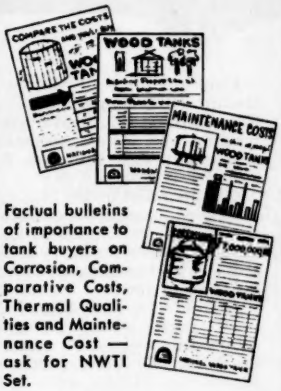
For applications such as mixing and storage of chemical solutions, raw materials, waste disposal, etc., nothing has more general utility than Wood, Nature's own corrosion proof material. Wood resists chemical action of practically all solutions within a pH range of 2 to 11, and commonly gives economical service even though attacked by stronger solutions, considering the low original cost.

Wood tanks properly made are highly resistant to decay, and have excellent insulating properties. Contents do not come in contact with metal. Erection of wood tanks is easy and cheap, even in close quarters and inaccessible areas. Initial cost is low. These factors make wood tanks ideal for many industries.

"POLYCEL"
A new kind of tank

A Wendnagel Wood Tank with Polymer Lining for handling high concentrations of either strong acids or alkalis. Now higher temperatures can be handled with new PVC formulations—to 180°F. Non-toxic liners available for foods and pharmaceuticals. Pipe connections easily made with ordinary fittings. Plastic covering for steel hoops. Be a "Corrosion Conqueror"—Specify Polycel.

Information Available



Factual bulletins of importance to tank buyers on Corrosion, Comparative Costs, Thermal Qualities and Maintenance Cost — ask for NWTI Set.

Reference and Data Handbook on Wood Tanks published by National Wood Tank Institute. Contains tables and facts for engineers.

Bulletin 60 outlines and illustrates Wendnagel non-corrosive wood products, hardware and ideas for chemical processing.

Write Today for Product Literature and Recommendations.
See Wendnagel Pages in Chemical Engineering Catalog.

WENDNAGEL & CO., INC.

613 W. Cermak Road • Chicago 16, Illinois • Phone: CAnal 6-2140

CPI NEWS BRIEF . . .

Continued from page 94

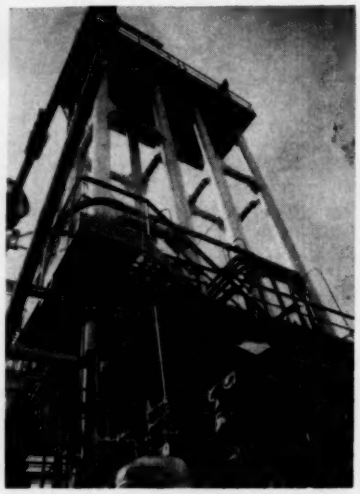
Humble's Bayway, N. J., refinery will be increased by 35%. The expansion will bring ethylene capacity up to 175 million lb./yr. at Bayway, and to about 845 million lb./yr. for Humble's over-all total. Project is set for completion in the second quarter of 1962.

United Carbon Co., Houston, has selected a site 85 mi. north of Los Angeles for its forthcoming West Coast carbon black plant. The tract occupies 45 acres, is near Mojave, Kern County, Calif. Initial capacity of the facility will be 64 million lb./yr., and production is scheduled to start by late this year. Engineering and construction are being handled by The Lummus Co., Houston.

Nopco Chemical Co. announced that construction has begun on a $7-million isocyanate plant that the firm will operate at Linden, N. J. Principal product will be toluene diisocyanate, an ingredient for manufacture of urethane foams. (Nopco is a producer of these foams, with manufacture centered at North Arlington, N. J.) The Linden facility is due on stream by early '62; initial design-capacity will be 10 million lb./yr. Engineering and design are being handled by Bechtel Corp., San Francisco.

American Potash & Chemical Corp. reports that construction is underway for its $5-million plant to produce manganese at Aberdeen, Miss. Site is adjacent to an existing sodium chlorate facility that the firm operates. The manganese project is scheduled for completion in November, and the contractor for it is Stearns-Roger Mfg. Co., Denver.

Miles Chemical Co. has announced plans to centralize its research on enzymes, bulk chemicals and fermentation products at Elkhart, Ind. As a main step in the centralization, the company will build two research pilot plants in that city for a total cost of $650,000. When the new facilities are completed, Miles will use them for research programs that have been in progress at Clifton, N. J., and Zeeland, Mich. The new pilot units are scheduled to be completed this summer.



Celanese Corp. of America's subsidiary, Celanese Chemical Co., has gone on stream with new facilities at its polyethylene plant near Houston. The new equipment, part of which is shown above, increases plant's over-all capacity to 60 million lb./yr. and produces a new line of high-density polyethylenes through a Celanese-developed process. Trademarked Fortiflex R, the new resins are said to offer greater toughness, processing versatility and range of applications than conventional linear polyethylene.

Minneapolis-Honeywell Regulator Co.'s Electronic Data Processing Div. plans to build a 75,000-sq. ft. manufacturing plant at Billerica, near Boston, Mass. Occupancy is scheduled for mid 1962. The division has signed purchase agreements for the required land; final transfer of the site will take place after the city rezones part of the land, and provided that engineering tests show the property to be suitable for the construction planned.

Texas Eastern Transmission Corp. has announced plans for an $83-million expansion program that will increase the delivery capacity of its natural-gas pipeline system

EXPLORE

the advantages of

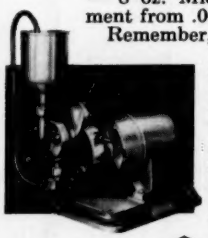
Gaulin Particle CONTROL

on your products

Find out for yourself how a Gaulin Homogenizer or Colloid Mill can improve your product and lower processing costs. You can rent one for only a few dollars a day.

Gaulin Laboratory Homogenizers — maximum capacity — 15 gph; minimum processable sample — 1 pint; pressure to 8,000 psi continuous; 10,000 psi intermittent.

Colloid RE Mill Model 2A — Capacity — 0-310 gph; minimum processable sample — 8 oz. Micrometer adjustment from .001 to .040.



Remember, the rental cost is applicable against the purchase price of the machines. Write for Laboratory Homogenizer Bulletin LH-55; RE Colloid Mill Bulletin — C-57.

Gaulin

MANTON

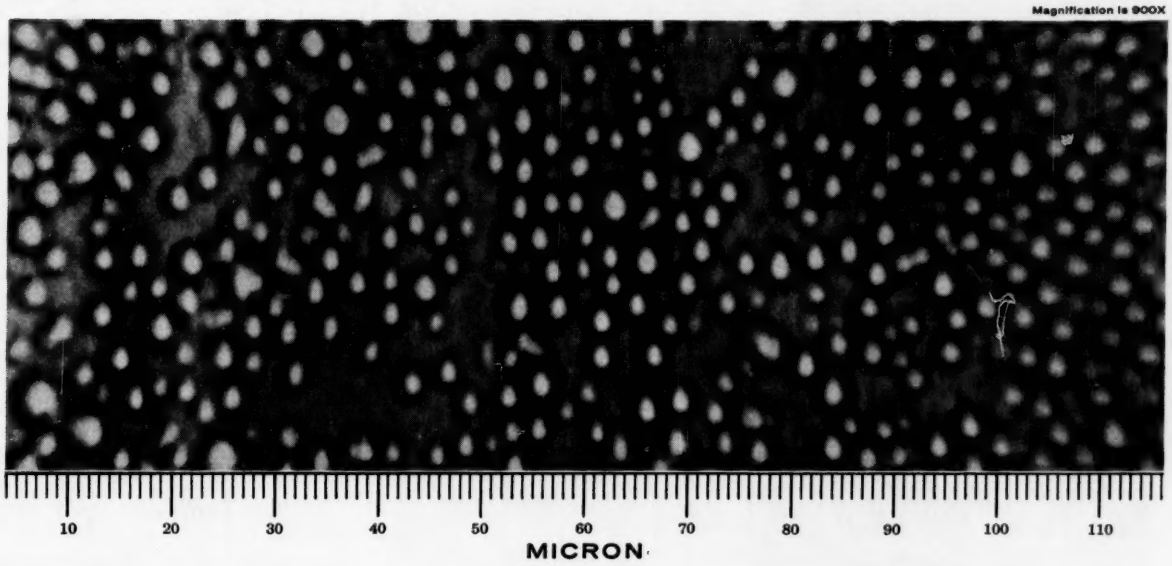
Gaulin

MANUFACTURING CO., INC.

71 Garden St., Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating pumps, pressure exchange pumps, dispersers, homogenizers and colloid mills.

Gaulin Particle Control



The Secret of Improved Products at Lower Costs

Important improvements can be made in the physical properties of your product through controlling its particle size.

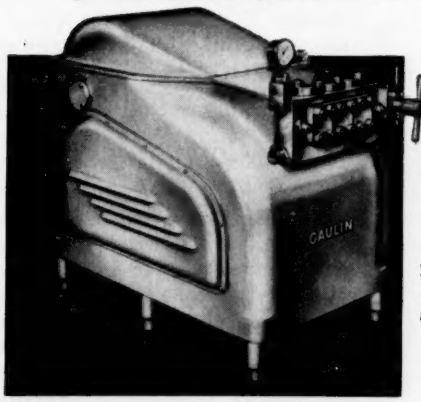
By reducing particles to their ultimate size you can improve everything from the speed with which it chemically reacts, to its taste, its lubricity and its color.

And by using Gaulin precision dispersers and emulsifiers you can maintain this particle size within very narrow limits — obtain greater uniformity at a far lower cost.

Gaulin Technical Assistance gives you a chance to fully explore the advantages of particle control.

Since we manufacture a complete line of homogenizers from (0-8000 PSI), colloid mills and submicron dispersers, we can provide you with the best means for achieving the particle size you desire.

See the Chemical Engineering Catalog for the address of your nearby Manton-Gaulin Industrial Sales Representative.



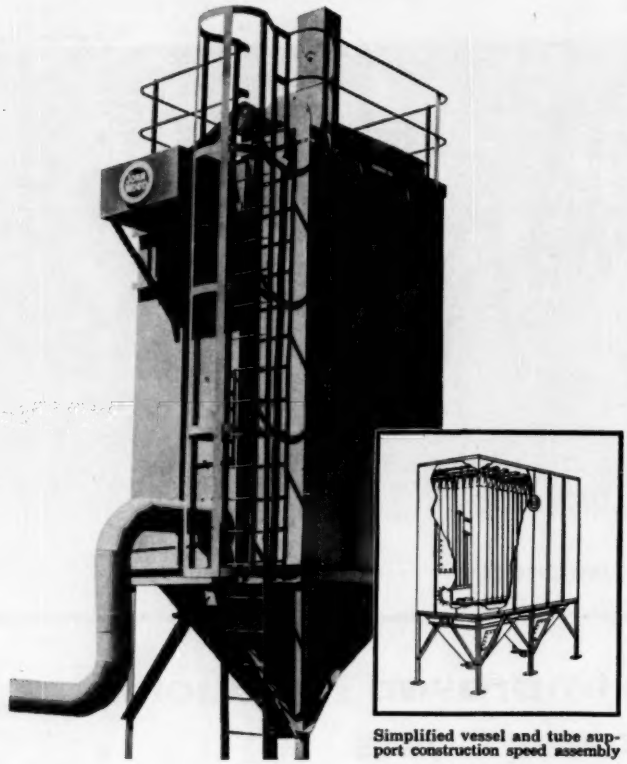
Gaulin TRADE MARK

MANTON
Gaulin
MANUFACTURING CO., INC.
71 Garden Street Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating pumps, pressure exchange pumps, dispersers, homogenizers and colloid mills.

Gaulin Technical Assistance starts with the GTA Library of Product Information. Ask for special bulletins prepared on each type of equipment. Then call on Manton-Gaulin for our specialized Technical Assistance. There's no obligation.

New Ideas On Dust And Fume Control



Simplified vessel and tube support construction speed assembly

New Products:

John Wood High Efficiency Fabric Filter

John Wood Fabric Filters are engineered for 99.9% efficiency in addition to trouble-free operation. They are the result of a program to design equipment for fully effective removal of all dry dusts at elevated operating temperatures.

An extremely varied group of filter sizes, shapes and types is available in capacities from 100 CFM to 48,000 CFM. Larger volumes are handled through a combination of units. John Wood automatic reverse flow mechanisms or shaker assemblies assure proper and gentle cleaning of fabric. Tubular or envelope bags are made of cotton, orlon, dacron, nylon or glass to meet any requirement.

New Engineering: John Wood Fabric Filters are but part of the complete line. Other equipment includes Interphase Reaction Scrubbers, Multi Cyclones, Involute Cyclones, Venturi Scrubbers and combination units. New designs are now under development.

New Service: John Wood Air Pollution Control is fully programmed from analysis of existing conditions to equipment installation. Frequently economies result that make the installation self-liquidating through lower maintenance and replacement costs.

Write for engineering assistance or specific product information. An air pollution preliminary analysis kit is available without obligation.

AIR POLLUTION CONTROL DIVISION
JOHN WOOD COMPANY
3 NICOLET AVENUE FLORHAM PARK, N. J. TUcker 7-3200

by 225 million cu. ft./day. Included will be a new pipeline across northern Louisiana into Mississippi, numerous loop and lateral pipelines, four new compressor stations, increases in compression horsepower at several existing stations, and associated metering and regulating facilities.

Company will accomplish the expansion over a two-year period, plans to install equipment leading to 108.8 million cu. ft./day of new capacity by next winter. Gas necessary for the program will be provided mainly by United Gas Pipe Line Co., Southern Natural Gas Co. and Texas Gas Transmission Corp. under long-term contracts.

Offices

U. S. Rubber Co.'s Naugatuck Chemical Div. has established a district sales office in Detroit. Company spokesmen say the main reason for opening this office is an increasing interest in the use of plastics in automobile manufacture.

Kraloy Chemtrol Co., a manufacturer of valves, pumps, plastic pipe and other items, has opened a district sales office and warehouse in Philadelphia. Firm's headquarters are in Santa Ana, Calif.

Ray Miller, Inc., a distributor of resistant piping materials, with company headquarters at East Orange, N. J., has opened a warehouse and office at New Orleans.

Companies

Tennessee Gas Transmission Co., Houston, has increased its natural gas reserves by over 1 trillion cu. ft., by purchasing from Pan American Petroleum Corp. the latter firm's producing leaseholds at Bastian Bay, Plaquemines Parish, La. Amount involved in the trans-

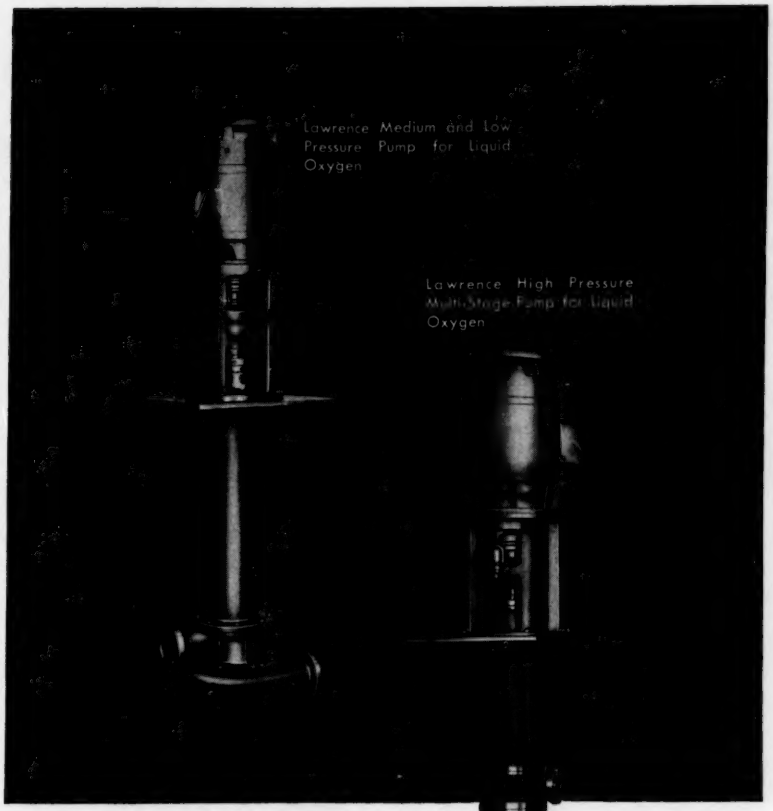
action is over $150 million. Gas deliveries from the leases into Tennessee Gas's pipeline system have already begun.

Mount Rainier Coal Co., subsidiary of Pacific Coast Co., San Francisco, has contracted to supply Mitsubishi Shoji Kaisha, Ltd., Tokyo, Japan, with 800,000 tons of coking coal for use in steel mills. Shipments of the coal will be over a 4-yr. period that is expected to begin early in 1962. This arrangement is said to represent the first long-term contracted use of western U.S. coking coal by Japanese steelmakers; currently, the Japanese receive coking coal from Canada, Australia and the Soviet Union.

Mount Rainier Coal holds subleases on coal properties owned by the Northern Pacific Railway Co. at Wilkeson, Wash., which have been operated only intermittently since 1936. The shipments to Japan will start after new washing equipment and other facilities have been installed at the mine on these properties.

Standard Beryllium Corp., New York, has purchased a concession in Brazil that contains reserves of beryl ore indicated at 14,820,000 tons. Named Boa Vista, the concession totals over 1,700 acres and is about 200 mi. north of Rio de Janeiro. Its former owner is Icombra, S. A., a company in which Standard Beryllium holds 25% equity. Latter company plans to have at least two mills extracting beryl and other minerals from the Boa Vista property by the end of this year.

Atlas Powder Co., Wilmington, Del., and The Stuart Co., Pasadena, Calif., are considering a merger proposal under which the California firm would become a division of Atlas. Stuart, organized in 1941, manufactures and markets ethical drugs throughout the U.S.; Atlas is a producer of explosives and industrial chemicals. Proposal will be submitted to the directors and stockholders of both companies.



PUMPS

***to handle* LIQUID OXYGEN *and other* LIQUEFIED GASES**

Lawrence Pumps Inc. has developed a special line of pumps for handling liquid oxygen, liquid nitrogen and other gases which can be liquified only at very low temperatures.

Because of the abnormal behavior of materials and liquids at extreme low temperature several of the following features are incorporated in these pumps:

1. Vertical top suction construction to prevent gas binding when the NPSH drops below the safe level, due either to drop in suction pressure, or rise in temperature of the liquid.
2. The packing box does not come in contact with the liquid, only with the blanket of gas in the pipe column.
3. The packing box is fitted with a mechanical seal which has been developed especially for this exacting service.
4. The design has been carefully developed and the materials selected to eliminate any troubles due to differences in expansion and to prevent galling between running parts.

Write for bulletin 203-8

LAWRENCE PUMPS INC.

371 Market Street, Lawrence, Mass.

CPI NEWS BRIEFS . . .

The Borden Co., New York, is negotiating to acquire the assets and business of Columbus Coated Fabrics Corp., Columbus, Ohio. Latter firm has total assets of over $18 million, is a manufacturer of fabrics coated with oil, nitrocellulose, polyvinyl chloride or acrylics, and also of unsupported polyvinyl chloride film. If the acquisition takes place, Columbus Coated Fabrics will operate as a division of Borden's subsidiary, Borden Chemical Co., while retaining its own name.

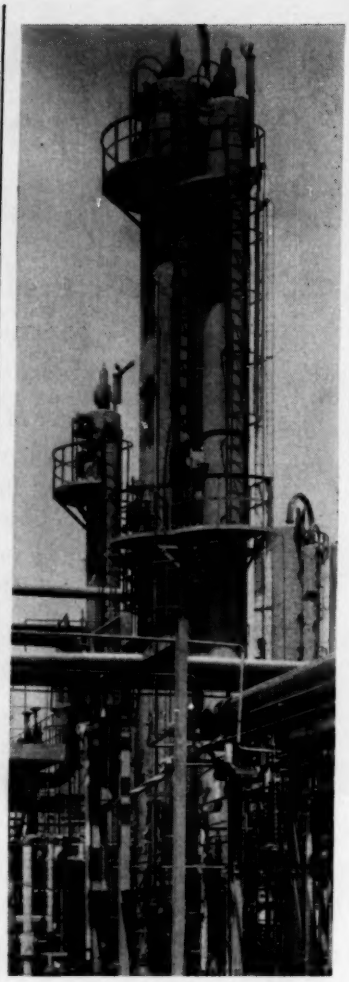
Lowry-Preston Technical Abstracts Co., Evanston, Ill., is a new company formed by partnership between the publishers of *Gas Chromatography Abstracting Service* and *Instrumentation Abstracts*. The new firm conducts abstracting in the fields indicated by these two titles, as well as custom literature-and patent-searching in these and other scientific fields.

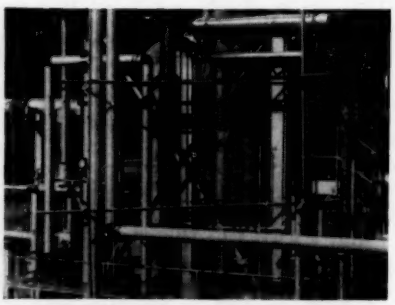
Union Carbide Plastics Co. and **Shell Chemical Co.** have entered into contracts for custom production of polypropylene and high-pressure polyethylene. Former company will produce polyethylene for Shell; the latter firm will manufacture polypropylene resins for Union Carbide.

International

Belgium: The Antwerp refinery of Societe Industrielle Belge des Petroles will undergo a $30.8-million expansion program, raising its capacity from about 80,000 bbl./day to 160,000 bbl./day. Main units planned are a 100,000-bbl./stream day crude-distillation unit with associated gas recovery facilities, a 9,000-bbl./day catalytic reformer for upgrading light distillates, a 10,000-bbl./day hydrofiner for desulfurizing gas oil, and a 60-ton/day sulfur recovery plant. Project will require about 2 yr. to complete.

Canada: Dominion Tar & Chemical Co., Ltd., will build a 22-million-





GET ARMCO STAINLESS STEEL FROM THESE STEEL SERVICE CENTERS

(A) Sheets, Strip and Plates (B) Bars and Wire

AMERICAN STEEL & ALUMINUM CORP. (A
Hartford, Conn.

AMERICAN STEEL & ALUMINUM CORP. OF MASS. (A
Cambridge, Mass.

BROWN-WALES COMPANY (A
Cambridge, Mass.—Auburn, Maine—Worcester, Mass.

CENTRAL STEEL & WIRE COMPANY (A
Chicago, Ill.—Cincinnati—Detroit—Milwaukee

CHICAGO STEEL SERVICE COMPANY (A
Chicago, Ill.

CLEVELAND TOOL & SUPPLY COMPANY
Cleveland, Ohio

THE CONGDON AND CARPENTER COMPANY (A
Providence, R. I.—Fall River, Mass.

C. A. CROSTA, INC.
Denver, Colo.

DUCOMMUN METALS & SUPPLY COMPANY (A
Los Angeles, Calif.—Berkeley—Phoenix—San Diego—Seattle

EDGCOMB STEEL & ALUMINUM CORP. (A
Hillside, N. J.

EDGCOMB STEEL COMPANY (A
Philadelphia, Pa.—Charlotte, N. C.—Greensboro, N. C.—York, Pa.

ESCO CORPORATION (A
Portland, Oregon—Denver—Emeryville, Calif.—Eugene, Oregon—Los Angeles—Seattle—Spokane—Vancouver, B. C.

PETER A. FRASSE & COMPANY, INC. (AB
New York, N. Y.—Buffalo—Hartford—Lyndhurst, N. J.—Philadelphia—Syracuse

FIRTH BROWN STEELS LTD. (AB
Montreal, P. Q.—Toronto

GATE CITY STEEL, INC.—OMAHA (A
Omaha, Nebr.

INDUSTRIAL STAINLESS STEELS, INC. (B
Cambridge, Mass.—Buffalo, N. Y.

EARLE M. JORGENSEN COMPANY (AB
Los Angeles, Calif.—Dallas—Denver—Houston—Oakland—Phoenix—Seattle—Tulsa—Wichita

MAPES & SPROWL STEEL COMPANY (AB
Union, N. J.

METAL GOODS CORPORATION (AB
St. Louis, Mo.—Dallas—Denver—Houston—Memphis—New Orleans—N. Kansas City, Mo.—Tulsa—Wichita

MONCRIEF-LENOIR MFG. COMPANY (AB
Houston, Texas—Dallas—Harlingen—Lubbock—San Antonio—Temple

MORRISON STEEL COMPANY (AB
New Brunswick, N. J.

THE ORLEANS STEEL PRODUCTS COMPANY, INC. (A)
New Orleans, La.

WILLIAM M. ORR COMPANY, INC. (AB)
Pittsburgh, Pa.

PAPER-CALMENSON & COMPANY (A)
St. Paul, Minn.

RICHARDS & CONOVER STEEL & SUPPLY COMPANY (A)
Kansas City, Mo.

SEABOARD STEEL & IRON CORP. (B)
Baltimore, Md.

SENECA STEEL SERVICE, INC. (AB)
Buffalo, N. Y.

SOUTHER STEEL & ALUMINUM COMPANY (A)
St. Louis, Mo.

J. M. TULL METAL & SUPPLY CO., INC. (AB)
Atlanta, Ga.—Birmingham—Greenville, S. C.—Jacksonville—Miami—Tampa

VIKING STEEL COMPANY (AB)
Cleveland, Ohio

VORYS BROTHERS, INC. (AB)
Columbus, Ohio

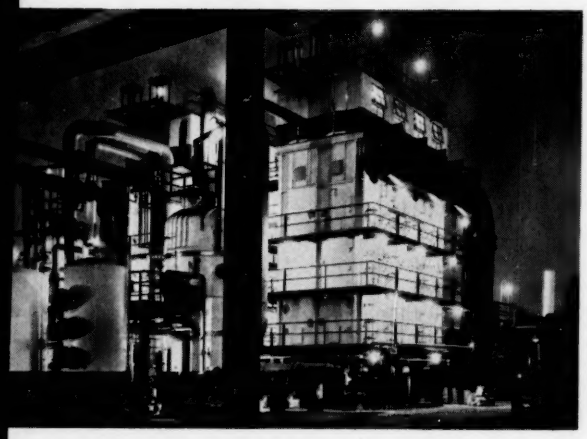
YORK CORRUGATING COMPANY (A)
York, Pa.—Washington, D. C.

Cut controllable costs two ways with Armco ELC Stainless Steels

Armco Extra-Low-Carbon Stainless Steels enable you to:

1. Reduce first cost of corrosion-resisting equipment.

2. Keep maintenance expense at a minimum.



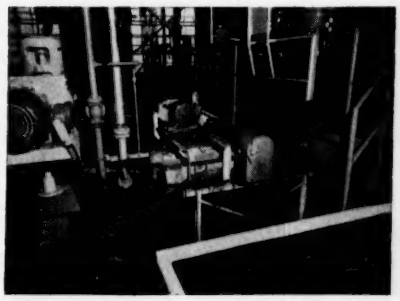
First cost of equipment made of Armco 304L, 316L, or 317L is lower because you can make full use of economical weldments . . . even field-weld without fear of harmful carbide precipitation. Provided operating temperatures are below 800 F, you eliminate the expense of using stabilized grades or annealing welded structures.

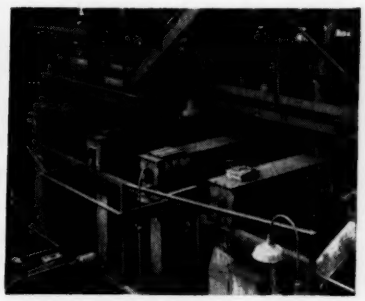
Maintenance costs are lower because field welding permits quick, simple repair or modification of equipment. Costly down-time is reduced.

Cut controllable costs in *your* plants by using Armco Extra-Low Carbon Stainless Steels for processing equipment that operates at 800 F or lower. Let us send you data on their application in the chemical industries. Write us or call your Distributor of Armco Stainless Steels. Armco Steel Corporation, 1551 Curtis Street, Middletown, Ohio.

Stainless Steel

For Durability, Strength and Economy





ARMCO **Armco Division**

Do-it-yourself cleaning saves chemical plant $800 yearly on each exchanger

A midwest chemical plant, running a battery of eight 20-foot oil cooler exchangers, found its average cost per yearly cleaning of each exchanger was $1100. Searching ways to cut costs, they called in their local Oakite man.

Here's what happened. The Oakite man studied the exchanger set-up and the type and quantity of deposits to be removed. He recommended the particular Oakite cleaning compound exactly suited to the purpose. Then—Oakite service being what it is—he donned coveralls and boots and stayed on the job supervising and testing while circulation cleaning took place on the worst exchanger of the lot.

This exchanger had been so fouled up that when it was removed from the line it made only one degree difference in temperature change. After a 24-hour cycle of circulation cleaning, it was put back in the line. Temperature change—13 degrees! The plant men who inspected it judged it to be 95% clean.

Best of all, cost of cleaning an exchanger, including time and materials, went down from $1100 to less than $300.

Exchanger cleaning is just one of the many chemical plant maintenance operations where Oakite can help to cut costs. For the full story, talk to your local Oakite man or write for detailed literature to Oakite Products, Inc., 16H Rector Street, New York 6, N. Y.

OAKITE

SCIENCE

over 50 Est. 1909 years' leadership in industrial cleaning

CPI NEWS BRIEFS . . .

lb./yr. phthalic anhydride plant adjacent to the firm's existing facilities in Toronto. Unit will cost about $3.5 million, will be engineered and constructed by Canadian Badger Co. Ltd., Toronto.

Iraq: A government spokesman has disclosed that the country's first chemical fertilizer plant is due to go on stream by 1965. It will be built near Basra, will have annual output of 116,000 tons ammonium sulfate, 56,000 tons ammonium nitrate and 20,000 tons sulfuric acid. Plant equipment will be supplied by the Soviet Union.

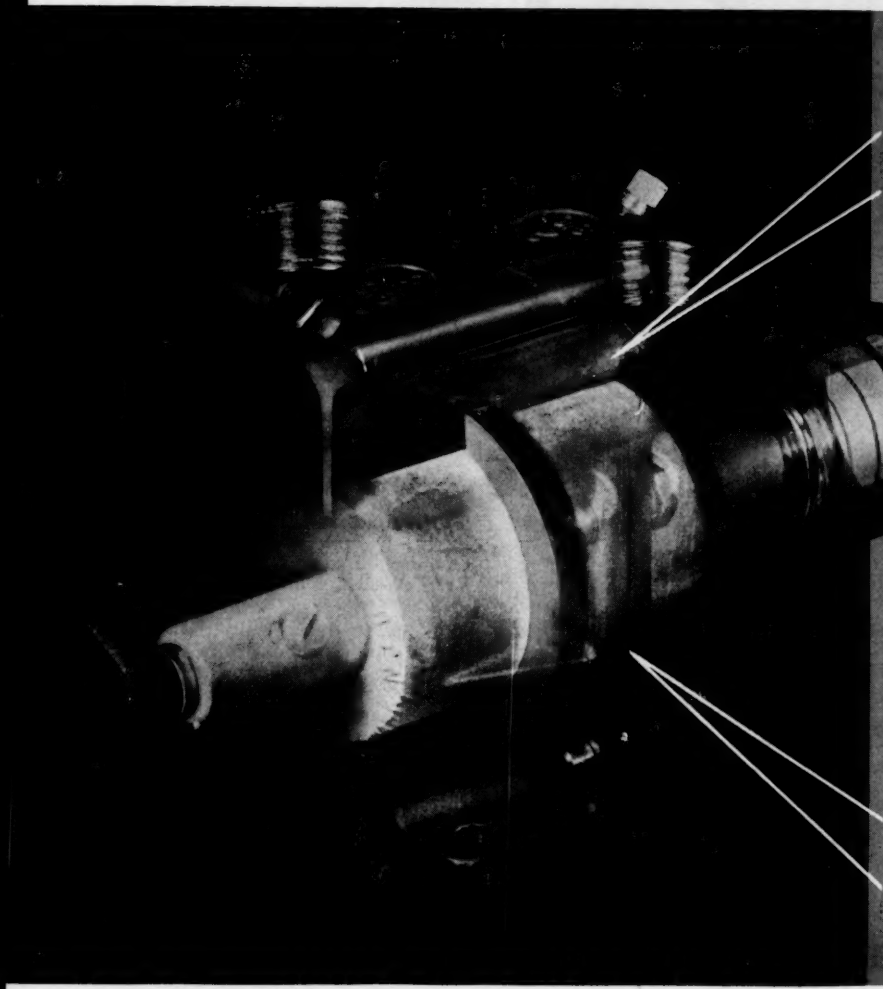
Mexico: Fertilizantes del Istmos, S. A., is a new company that will initially operate a $2.5-million plant on the Isthmus of Tehuantepec to produce urea, ammonium nitrate, ammonium sulfate, ammonium phosphate, superphosphates and other products. A major stockholder in the venture is the country's petroleum organization, Pemex.

Italy: Mobil Chimica Italiana S.p.A. is a newly formed Italian affiliate of Socony Mobil Oil Co., Inc., New York; it will build a plant at Naples to produce benzene, ethylbenzene, orthoxylene and paraxylene. Initial output will be about 39 million U. S. gal./yr., over 75% of which will be benzene and orthoxylene. Major part of raw-material requirements will be supplied by an adjacent refinery operated by Mobil Oil Italiana.

England: U. S. Rubber Reclaiming Co., Inc., Buffalo, and England's Dunlop Rubber Co., Ltd., have entered into a joint venture to build a $2.1-million rubber reclaiming plant near Liverpool. Facility will be modeled after U. S. Rubber Reclaiming's plant at Vicksburg, Miss. (*Chem. Eng.*, Nov. 28, 1960, p. 167.).

Australia: Amoco Australia, Ltd., headquartered in Sydney, is a new petroleum refining and marketing subsidiary of Standard Oil Co. (Ind.). It plans to build a 15,000-bbl./day refinery near Brisbane.

LOOK INTO...
ECO ALL-CHEM® PUMPS



Twin opposed oscillating impellers provide linear non-segmented, non-foaming flows ideal for shear-sensitive emulsions and safe for auto-detonating fluids. Capacities to 10 gpm, pressures to 75 psi, viscosities to 900 SSU.

Drives; direct electrical motor, air motor, pulley, sprocket, and hydraulic or mechanical variable speed drives.

Designed for severe corrosive service. Housing and Shafts; 304, 316 and Carpenter 20 stainless steel or Hastelloy* B and C. Impellers; Teflon†, phenolic or polyamide resins, Hypalon†, etc. Bearings and Seals; self-lubricated Teflon.

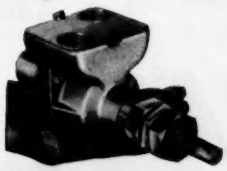
ECO

the big-name in small pumps for the process industries

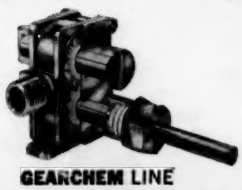
Write for Literature on any or all of the Eco stock pumps shown below for handling corrosive or hazardous processing fluids.

*Union Carbide Trademark. †du Pont Trademarks.

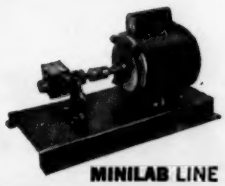
CENTRI-CHEM LINE



ALL-CHEM LINE

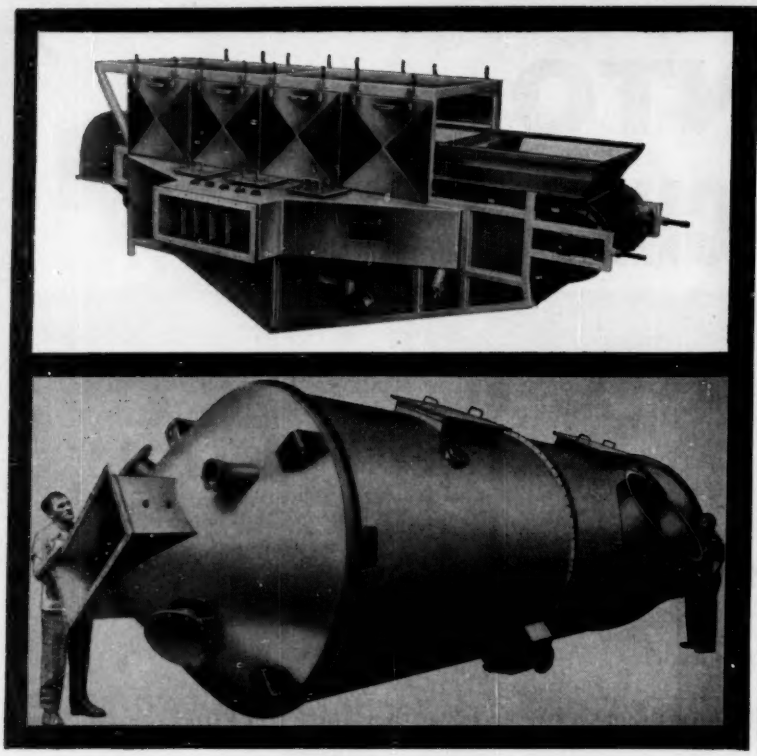


GEARCHEM LINE



MINILAB LINE

ECO ENGINEERING COMPANY · 12 New York Avenue · NEWARK 1, N.J.



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Convention Calendar

March

20-24. American Society of Metals, 12th Western Metal Congress, Ambassadore Hotel, and Western Metal Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

20-31. Purdue University, 9th Annual Industrial Packaging Course, Lafayette, Ind.

21-30. American Chemical Society, National Meeting, Kiel Auditorium, St. Louis, Mo.

21-23. Illinois Institute of Technology and American Society of Mechanical Engineers, American Power Conference, Sherman Hotel, Chicago, Ill.

27-31. Instrument Society of America, Symposium on Temperature, Its Measurement and Control in Science and Industry, Veteran's Memorial Hall and Deshler-Hilton Hotel, Columbus, Ohio.

April

5-7. Institute of Environmental Sciences, 1961 Annual Meeting and Equipment Exposition, Sheraton Park Hotel, Washington, D. C.

5-7. Department of Health, Education and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Symposium on Ground Water Contamination, Sheraton-Gibson Hotel, Cincinnati, Ohio.

6-7. American Society of Mechanical Engineers, Management Engineering Conference, Statler-Hilton Hotel, New York, N. Y.

9-13. American Society of Mechanical Engineers, Oil & Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

10-11. American Institute of Electrical Engineers, Rubber and Plastics Industries Conference, Sheraton Hotel, Akron, Ohio.

10-11. American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

10-11. The Combustion Institute, Western States Section, 1961 Spring Meeting, Aeronutronic, Newport Beach, Calif.

10-12. The Metallurgical Society of American Institute of Metallurgical Engineers, 44th Annual Conference, Sheraton Hotel, Philadelphia, Pa.

10-12. Western Petroleum Refiners Assn., 49th Annual Meeting, Grenada Hotel, San Antonio, Tex.

10-13. American Management Assn., National Packaging Exposition, McCormack Place, Chicago, Ill.

11-12. American Institute of Electrical Engineers, Materials Handling Conference, Pick-Congress Hotel, Chicago, Ill.

11-12. Instrument Society of America and the Society For Applied Spectroscopy, 1961 Ohio Valley Instrument-Automation-Electronic Exhibition and Symposium, Cincinnati Gardens, Cincinnati, Ohio.

11-13. American Society of Lubrication Engineers, Annual Meeting & Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa.

12-14. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., International Symposium on Agglomeration, Sheraton Hotel, Philadelphia, Pa.

12-14. German Plastics Meeting, West Berlin, Germany.

13-14. Oklahoma State Univ., Heat Transfer Conference, Stillwater, Okla.

13-15. The Metallurgical Society of American Institute of Metallurgical Engineers, Pacific Northwest Metals and Minerals Conference, Davenport Hotel, Spokane, Wash.

17-19. Instrument Society of America, 7th National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Tex.

17-19. Purdue University, Conference on Manufacturing Automation, Lafayette, Ind.

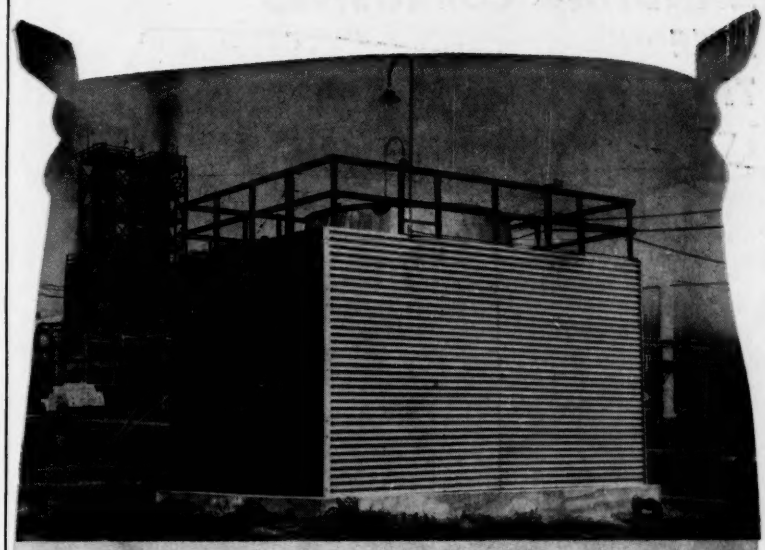
18-20. National Institute for Disaster Mobilization, Industrial Mutual Aid & Disaster Control Seminar, Shamrock-Hilton Hotel, Houston, Texas.

18-20. American Welding Society, Annual Welding Exposition, Coliseum, New York, N. Y.

19-22. Instrument Society of America, 7th Southeastern Regional Conference and Instrument Exhibit, Park Center, Charlotte, N. C.

20-21. The Society of the Plastics Industry, Inc., 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Calif.

20-21. American Institute of Mining, Metallurgical and Petroleum Engineers, Gas Technology Symposium, Tyler, Tex.



Fertilizer Plant
Increases Its Own "Yields"
with a
MARLEY
DOUBLE-FLOW AQUATOWER®

For top performance at absolute economy, there is nothing like the Marley Double-Flow Aquatower in the intermediate-capacity field of water cooling. That's why this fertilizer processor selected a Series 14 Double-Flow Aquatower to increase the profit yield at its nitrogen-fixation plant.

Process cooling is one of the more obvious "hot spots" in a plant that can be changed into "profit spots" by a Marley cooling tower. Not so obvious, but equally important to plant efficiency and profits, are a host of other industrial operations that require 25 gpm or more — air conditioning, refrigeration, steam condensers, compressors, welding equipment, candy slabs, molding pieces, quenching baths. Alert plant engineers are eliminating these water-wasters with Marley cooling towers that soon pay for themselves.

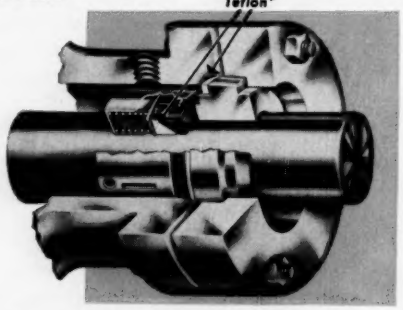
The complete Marley line of cooling towers ranges from small packaged units for "spot cooling" to giant industrial towers. Your nearby Marley Application Engineer in any of 56 cities will be glad to make a survey of your water cooling requirements to show you how to convert your "hot spots" into "profit spots". Call him today—his services are yours without obligation; or write to

the Marley company
Kansas City, Missouri

Performance records plainly prove that this "John Crane" development has successfully solved the handling of the most difficult corrosive liquids and gases. Where conventional type seals had failed, the Type 9 has done the job. It continues to answer new problems, including temperature conditions from —120°F. up to 500°F.

Designed to withstand practically all chemicals, the Type 9 incorporates a flexible wedge ring and sealing ring molded from DuPont's Teflon. It is engineered for the particular application and can be furnished in the metallurgical specification best suited to the service.

Your toughest problem can be the Type 9's next success story. Use it on all rotating shaft applications, including: centrifugal, rotary pumps, mixers, agitators, autoclaves, other equipment.



Get complete information on the Type 9 Seal from Crane Packing Co., 8451 Oakton St., Morton Grove, Illinois, (Chicago Suburb).
In Canada: *Crane Packing Company, Hamilton, Ont.*
**DuPont trademark*

MORE NEW EQUIPMENT . . .
Continued from page 112

tion, sounds the alarm if turbidity exceeds a preset range.

The complete unit consists of a flow cell, light source, photoelectric scanner and the indicator/controller unit. Light source and scanner are mounted on opposite sides of the flow cell, which is installed directly in the process stream. Changes in turbidity that affect light transmittal are indicated on a meter.

Equipped with standard flanges to fit 1 to 6-in. pipes, the device exhibits almost no pressure drop while providing direct analysis of the stream. Opening a simple clamp gives access to the cell windows for cleaning. The indicator/controller unit may be placed up to 100 ft. from the flow cell—**Jacoby-Tarbox Corp., Yonkers, N. Y.** **112E**

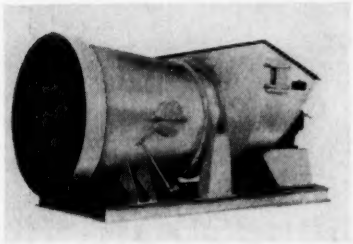
Micromanometer

Ultrasensitive pressure-measurer reads differentials electrically.

Capable of measuring differential gas pressures in the range of 0.00016-10.0 in. H_2O, this linear-scale micromanometer consists of two symmetrical cavities separated by a metal diaphragm, and two fixed electrodes. Movement of the diaphragm causes a variation in the capacitance between it and each adjacent electrode. This difference is measured and flashed to the panel meter. In effect, the two cavity-electrode systems act as individual condensers; each is coupled to an R.F. oscillator, and miniature tuning systems result.

Interchangeable measuring heads can be snapped onto the

instrument to alter its range of readings. The most sensitive head measures pressure differentials from 0.00016-0.004 in. H_2O. Pressure loads of as much as 1,000 psi. can be applied to the unit without damage.—**Gelman Instrument Co., Chelsea, Mich.** **204A**



Axial fan

Design feature: impeller blades are adjustable during operation.

Air (or other gas) flow can be varied instantly with this new axial fan. Its impeller blades can be adjusted while it is in operation—but it keeps running at constant speed.

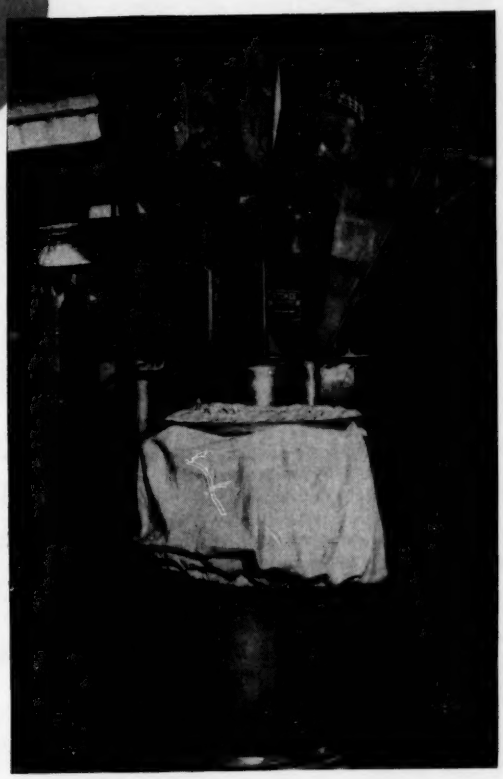
Forty-eight standard sizes are available, for flows ranging from 30,000-600,000 scfm. The fan has a higher speed than centrifugal models; it can be hooked up to motors running at 725, 980 or 1,450 rpm. — **American SF Products, Inc., New York.** **205A**

Cooling sifter

Sift and cool, cool and sift—same machine does either.

Called Gyro Cooler, a new sifter cools as it sifts, cuts down space requirements where the two operations must be done by doing them simultaneously. Gyratory motion at the inlet end of the machine provides contact of solids with coolers, coils, which are

5 big reasons why Pennsalt chose the Stokes tornado mill...



- **Versatility** in speed, in size of particles it handles, in the rate of production, in the different basic materials with which it can be used
- **Portability** Pennsalt uses it in several different locations throughout the plant
- **Easier-To-Clean** Tornado Mill can be cleaned in 1-hour. It formerly took a full day to clean the size reduction equipment
- **360° screen** provides full working area
- **Minimum Maintenance—** Only two spare parts required

Pennsalt uses the Mill in size reduction of dry Sal Ammoniac and dry Actidip*.

Whatever you are contemplating, investigate the Stokes Tornado Mill. More and more companies everyday are learning the new way to "size reduce".

The Stokes Advisory Service will be glad to run tests on a sample of your material. Call or write . . . today.

*Registered tradename

Size Reduction Equipment Division
F. J. STOKES CORPORATION
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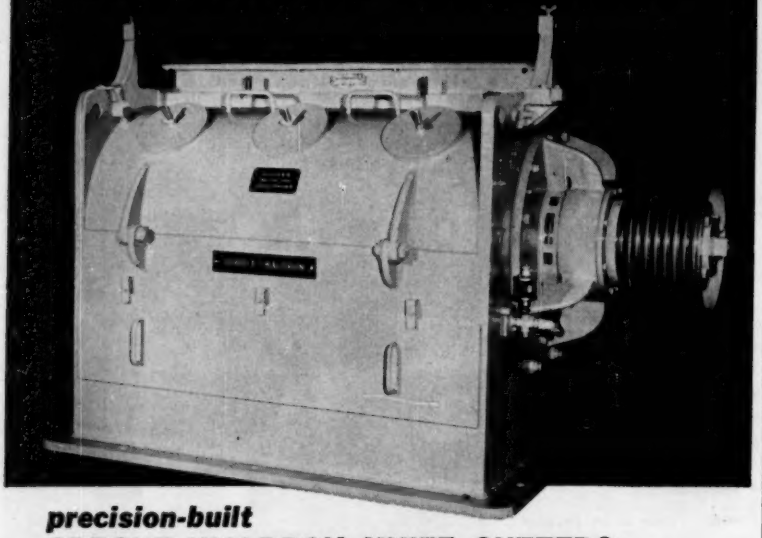
GRANULATES THIN SCRAP POLYETHYLENE SHEETS .001" to .002" thick

with better flow characteristics



precision-built

SPROUT-WALDRON KNIFE CUTTERS

for tough cutting jobs

It's true, no two jobs of size reduction are the same, but Sprout-Waldron precision engineered knife cutters are doing a lot of tough size reduction jobs with superior results. Their application and versatility are practically unlimited.

Such tough cutting jobs as these—*and others*—are being handled efficiently on Sprout-Waldron cutters . . .

Rubber reduction; cutting thin plastic film sheets continuously; flocking alpha pulp; pre-cutting and flocking rags, fabrics, leather and other fibrous materials; granulating thermoplastics, chalk and charcoal; and processing tobacco leaves, stems, vegetables, roots, shavings, bark, foil, chemicals, drugs and other materials.

Check with Sprout-Waldron on your size reduction problems . . . our modern testing facilities and years of design, engineering and manufacturing experience are available to assist you. *Write for Bulletin 213.*

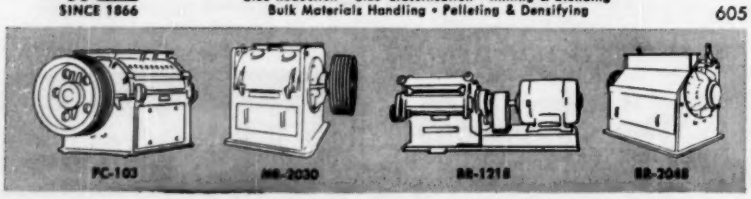
SW SINCE 1866

SPROUT, WALDRON & CO., INC.

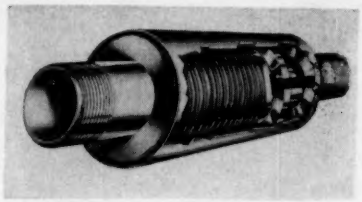
MUNCY, PENNSYLVANIA

Size Reduction • Size Classification • Mixing & Blending
Bulk Materials Handling • Pelleting & Densifying

605



formed on the underside of a flat pan. A continuous flow of cold water or brine carries away the heat. Coils are accessible for cleaning through inspection doors. Components may be arranged so gyro cooler will sift and then cool, or vice versa. — **The Young Machinery Co., Muncy, Pa.** **205B**

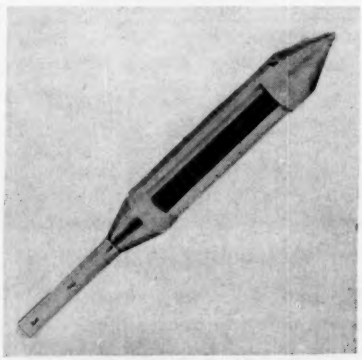


Expansion compensator

Stainless steel device absorbs thermal growth in pressure pipe.

Designed to check expansion in pipes that are under pressure as high as 175 psi. and temperature up to 750 F., this compensator comes in sizes ¾ to 3 in. It fits pipe diameters as large at 3 in.

Features: screwed, welding or flanged ends; heavy-duty bellows; positive antitorque mechanism; protective shroud; stainless steel construction. — **Flexonics Corp., Maywood, Ill.** **206A**



Sample extractor

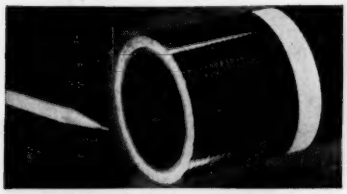
To take deep samples from bags, shipping sacks, drums—try this.

For quality control or testing, this sample extractor grabs and pulls out samples of grains, pow-

TEST PROVES CORROSION RESISTANCE . . . Stainless Steel 316 pipe (at left) and Fibercast Pipe were tested in 54% P_2O_5 solution at 290° F using modified ASTM A-262-55T formula. The stainless steel pipe showed .778" penetration per month; yet the Fibercast showed no deterioration whatsoever.

New pipes eliminate corrosion problems in processing industries!

- *handles a temperature range from −65° to 300° F.*
- *withstands an operating pressure range up to 1200 psi.*
- *pipe sizes from 2" to 8"*



WHAT is Fibercast?

It is centrifugally cast, thermoset, epoxy resin reinforced pipe that handles temperature and pressure problems where no other pipe will do. Its body of woven glass fibers resists high tension forces, is embedded and bonded by heat in epoxy resin. Result: strong, long-lasting pipe that resists high pressures and temperatures in corrosive environments.

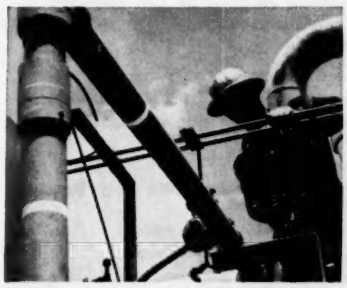
WHEN should Fibercast be used?

Whenever ease of handling, light weight, dielectric properties and structural stability are desirable in a piping material that is at the same time outstandingly resistant to heat, pressure and particularly corrosion.

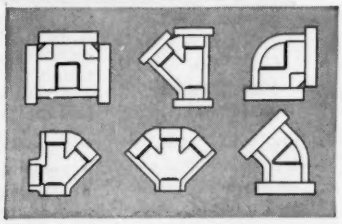
Examples: Petroleum industry . . . chemical . . . petro-chemical . . . nuclear energy . . . textile . . . paper . . . food-processing . . . and countless other operations handling acids, alkalies, salt water and other corrosive liquids under pressure.

WHY use Fibercast?

Fibercast's remarkable lasting qualities . . . its amazing resistance to "impossible" temperature and pressure conditions . . . make it a long-lived, cost-saving, maintenance-saving pipe. Remember, too: Fibercast has the world's most complete stock of standard fittings, as well as couplings designed and made to order for individual requirements.



Workman is shown with section of Fibercast pipe bearing 32% HCl at a Shell chemical plant. Note that Fibercast has sufficient strength for installation on span racks with the spacing normally used for metal pipe.



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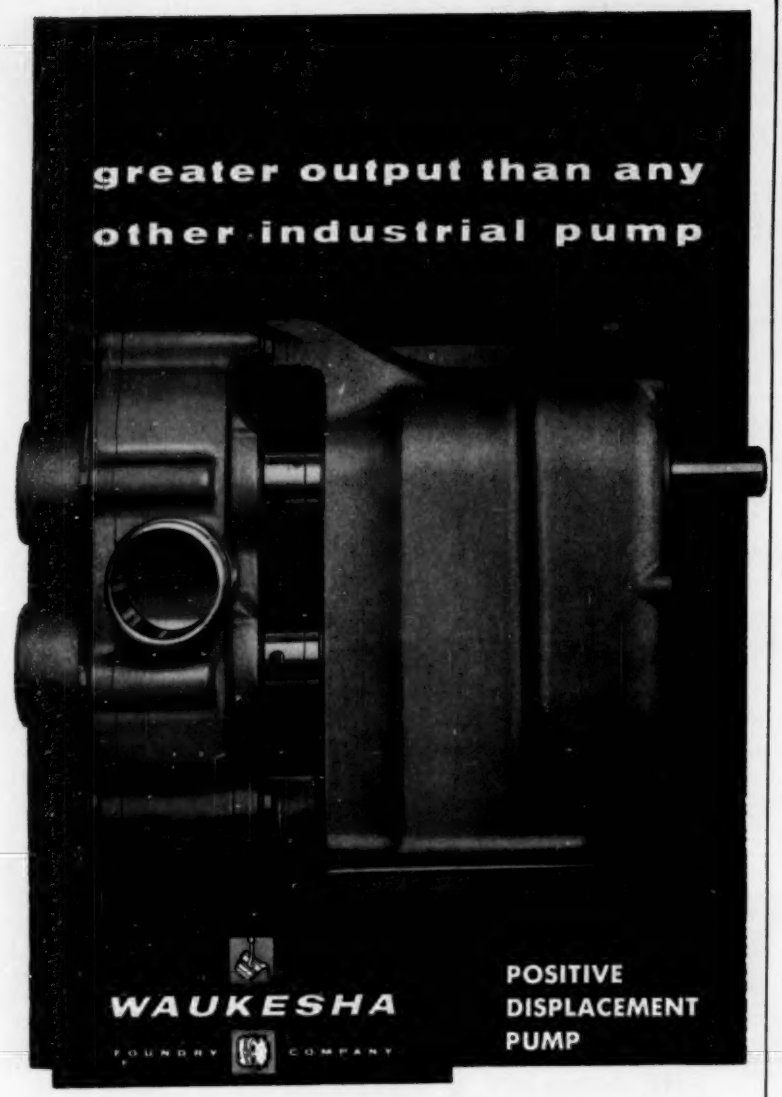


A new "Waukesha" designed and engineered to deliver less turbulence, pulsation, aeration and agitation on products of high or low viscosity . . . a smoother operation which assures longer life, less maintenance.

- twin-balanced impellers
- single or dual mechanical seals (John Crane)
- interchangeable packing gland or mechanical seal construction
- self priming
- shaft supported by three heavy-duty bearings to eliminate deflection
- iron pipe or flange-type connections
- quick disassembly of pumping head
- helical timing gears
- off-shelf replacements

ENGINEERING SERVICE

Waukesha offers a competent staff of engineers to aid you in your pumping problems. Representatives in all major cities, territorial managers, and direct factory representatives.

Write for Catalog P302

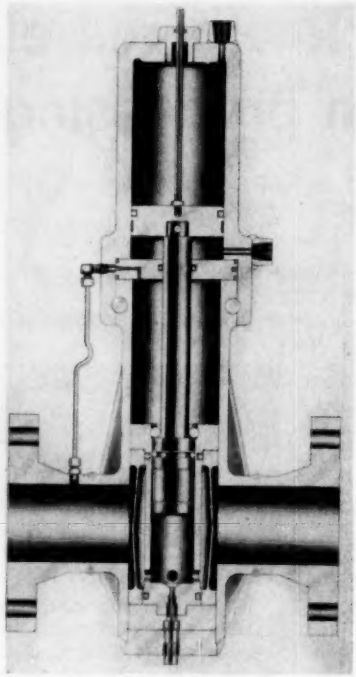
WAUKESHA FOUNDRY COMPANY
Dept. #91B, Waukesha, Wisconsin

positive displacement pumps . . . centrifugal pumps . . . stainless steel valves and fittings . . . corrosion resistant castings

ders or liquids from deep inside shipping bales and similar containers.

Rustproof and corrosion-resistant, unit is lightweight and simple to operate. A flick of the wrist is all that's required to trap the sample.

Two models are available: one has a sample chamber measuring 2 × 15/16 in. and goes to a maximum depth of 24 in.; the other measures 6 × 2 in. and reaches down 48 in.—**Testing Machines Inc., Mineola, L. I., N. Y. 206B**



High-pressure valve

Pipeline valve puts emphasis on automatic, remote control.

This high-pressure, remote-control valve contains a built-in operator. It's regulated either by line pressure alone or by normal pneumatic, hydraulic and electric systems.

Seal is leakproof; sealing pressure is proportional to and directly opposes line pressure. Valve is full-flow, nonlubricated. It handles liquids, slurries and gases. Now undergoing field tests, it is available for licensed manufac-

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS

KEL-F® BRAND Dispersion coating helps tanks shrug off abrasion, hot acids—prevents "plate out"!

Metal Processing Co., Cedar Grove, N.J., relies on KEL-F Brand Dispersion coating to provide tough linings for the nickel-plating tanks it manufactures (see photo above). Reason—this coating wards off damage by acids and abrasion . . . prevents "plate out," the chemical reaction of plating solutions with the tank's metal surface.

KEL-F Dispersion coatings are chemically inert both to plating acids, heated to 200°F., and to the nitric acid used in tank clean-up. The smooth, non-porous coating is *pinhole-free* and, because of excellent resistance to wear and abrasion, is not readily damaged by parts being plated. Result—tank linings last up to two years! Industrial Coatings Division of The National Glaco Chemical Corporation, Fair Lawn, N.J., is the supplier that applies KEL-F Dispersion for Metal Processing Co.

At right is a summary of additional features of KEL-F Dispersion that are helping chemical processors prevent corrosion and contamination.

PROPERTIES PROFILE

KEL-F Dispersion coatings BRAND

KEL-F Dispersion consists of particles of KEL-F Plastic suspended in a volatile liquid. This dispersion is applied by spray, dip or other methods, then heat-fused to form tough, permanent coatings with the basic properties of regular KEL-F Plastic.

RESIST CHEMICALS! KEL-F Dispersion coatings withstand attacks by acids, alkalies, gases and oxidants. Some specific examples of weight change after exposure at 25°C. for 7 days:

Chemical	Weight change
Benzene	0.2%
Hydrochloric acid, 37%	0.0%
Hydrogen peroxide, 90%	0.0%
Fuming nitric acid, 98%	0.0%
Sulfuric acid, 95%	0.0%
Anhydrous ammonia	0.0%

RESIST STICKING! Outstanding anti-adhesive properties resist such materials as glues, inks, paints, greases, waxes, etc., to make cleaning easy!

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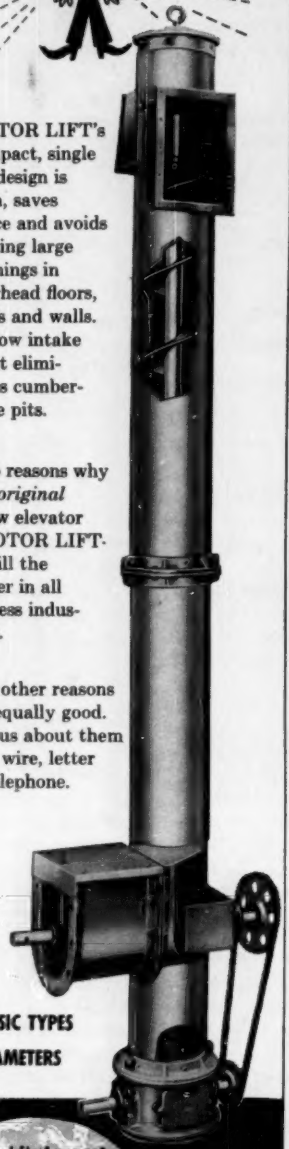

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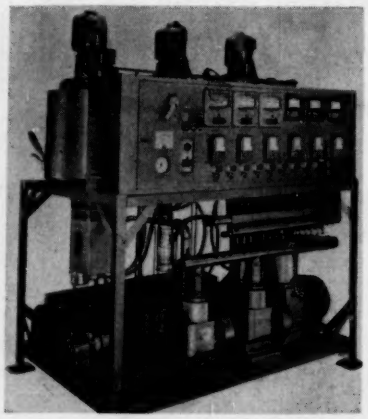
NEW EQUIPMENT . . .

ture. Capacities of 500, 1,500 and 3,000 psi. are anticipated. — **KeXplore, Inc., Houston.** 208A



Molecular still

Pilot-size unit processes materials of molecular weight 250-4,000.

Three complete distillation units coupled in series make up this molecular still that is particularly effective in processing materials of molecular weight 250 to 4,000. Unit preheats, degasses, strips, recovers low-boiling components continuously, and distills the major compound.

Recorders monitor each control factor while the unit distills such materials as lanolin, sugar esters, organometallic compounds, high-temperature lubricants and pharmaceuticals. — **Arthur F. Smith, Inc., Rochester, N. Y.** 210A

Briefs

Potentiometer has nine interchangeable, direct-reading scales for use with any type of thermocouple. Improved circuit adds stability, makes the instrument insensitive to ambient temperature. —**Technique Associates, Indianapolis, Ind.** 210B

Flow indicator lets you look inside a pipeline to determine flow, direction and condition of fluid. It has double sight glasses that pro-

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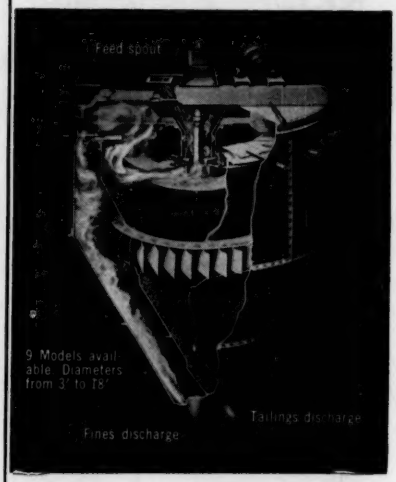

Closed-circuit air separation is of proved advantage in reduction processes. Result is a better, more uniform product. Grinding mills perform at top efficiency, output frequently increases as much as 300%, power costs drop as much as 50%.

Precise separation of all dry powdered materials. Sturtevants currently classify sulfur, soybeans, phosphate, chocolate, feldspar, sand and aggregates, pigments, limestone fillers, flour, abrasives, plastics, gypsum, ceramics, cement and other products.

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Sturtevant Air Separators do a mechanical job of winnowing. Precise control of whirlwind air currents and centrifugal force results in the desired size being lifted into fines cone, oversize falling into tailings cone.

A 16 ft. Sturtevant, for example, has taken a feed rate of 800 tph, containing only a *small* percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit.

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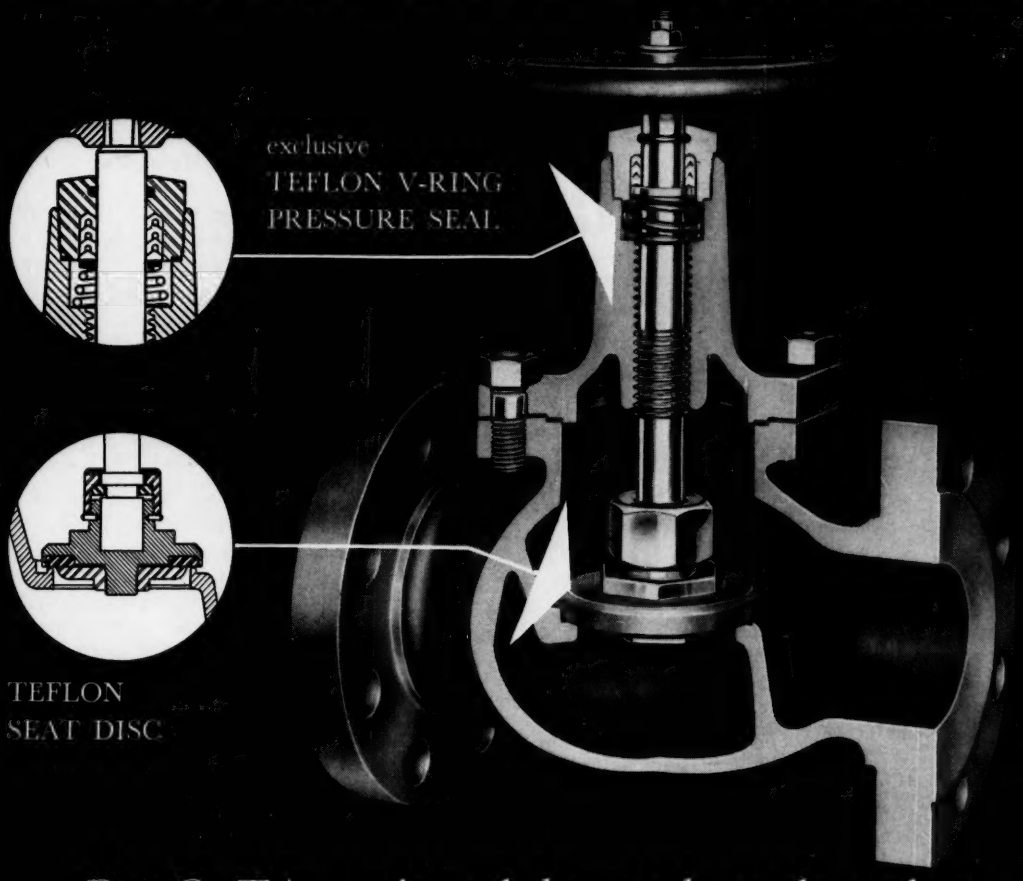

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An outstanding value—wear and maintenance problems drastically reduced. Rugged Ductile Iron Body won't crack or fracture from wrenching or dropping. Centerless ground stainless steel stem, won't gall, pit or freeze. Spring-loaded for tight seal at low pressures; V-shaped seal expands under added pressure.

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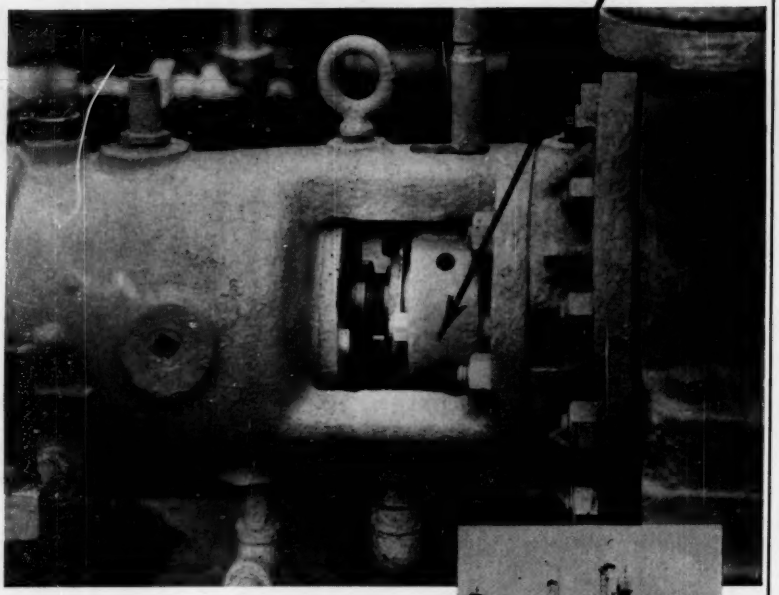

Maintenance required —NONE!

Pumping gasoline stabilizer at a temperature of 320°F, and pressure of 300 psig, the Bel Oil Company, Elton, Louisiana, has chalked up a record of 8½ years of almost continuous, day and night service—without any kind of maintenance on this Type U Borg-Warner Mechanical Seal.

When finally taken down after this record run, only the gaskets and seal faces were replaced, and the old faces were re-lapped and returned for use as spares.

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mote clear viewing even under poor lighting conditions. Unit is priced lower than high-pressure, high-temperature models of same company.—**Schute & Koerting Co., Cornwells Hgts., Pa.** 210C

Air filter is said to be 99.998% efficient on dust, down to 0.3 micron in diameter. Made of polystyrene, it is capable of retaining high dust loadings without significant changes in filter resistance. Now available in limited quantities for about $2/sq. ft.—**Gelman Instrument Co., Chelsea, Mich.** 212A

Flexible pigtail, made of Teflon liner reinforced with braided stainless steel cover, is rated to 3,000 psi. Chemically inert to almost all high-pressure gases, it is available, with connections matched to CGA and other standard specifications, for acetylene, helium, LP-gases, nitrogen, oxygen, others.—**RegO Div., The Bastian-Blessing Co., Chicago.** 212B

Equipment Cost Indexes . . .

	Sept. 1960	Dec. 1960
Industry		
Avg. of all	237.4	237.3
Process Industries		
Cement mfg.	231.7	231.6
Chemical	238.6	238.1
Clay products	225.6	225.1
Glass mfg.	225.3	224.8
Paint mfg.	229.1	229.4
Paper mfg.	229.9	229.4
Petroleum ind.	234.0	234.3
Rubber ind.	237.9	237.1
Process ind. avg.	236.2	236.1
Related Industries		
Elec. Power equip.	240.2	238.3
Mining, milling	240.0	239.5
Refrigerating	267.7	268.0
Steam power	224.3	224.5

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 6, 1961, pp. 115-116 for annual averages since 1913.

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Technical Bookshelf

CHEMISTRY UPDATED

PROGRESS IN INORGANIC CHEMISTRY. VOL. 2. ED. BY F. A. COTTON. INTERSCIENCE. 300 PAGES. $10.50.

Reviewed by Rowland E. Johnson, Texas Instruments Inc., Dallas, Tex.

With the recent rapid growth of inorganic chemistry, the gap has widened between diffuse literature in periodicals and textbook compilations of data. In critically reviewing selected topics to fill this gap, the present volume is one of a series that yields a real service to all chemists.

"Progress in Inorganic Chemistry" presents seven articles by authorities well known in their field. Four of these articles are generally descriptive, on classes of inorganic compounds. The subject matter: a chapter on halides and oxyhalides of the elements of the groups Vb and VIb by John W. George; a chapter on fluorine compounds of the transition metals by R. D. Peacock; one on unusual oxidation states of actinide and lanthanide elements by L. B. Asprey and B. B. Cunningham; and one on metal alkoxides by D. C. Bradley.

These sections outline the general state of knowledge of the compounds of interest, give a description of their properties and methods of preparation, and discuss the interest being shown in them today.

A chapter on radioactivation analysis in inorganic geochemistry by John W. Winchester describes the extension of this method of analysis to elements in the earth's crust. An article titled "Extraction of Inorganic Compounds into Organic Solvents" by R. M. Diamond and D. G. Tuck cites the powerful methods of separation and concentration available through use of organic solvents. C. J. Ballhausen's "Intensities of Spectral Bands in Transition Metal Complexes" details one method of attack in understanding the electronic configuration of the compounds that are under discussion.

While the articles are certainly not elementary, a chemist will have

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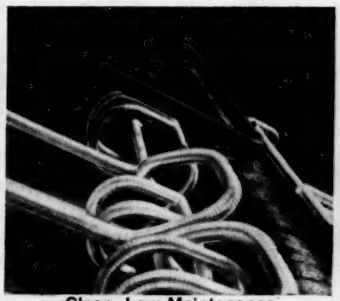

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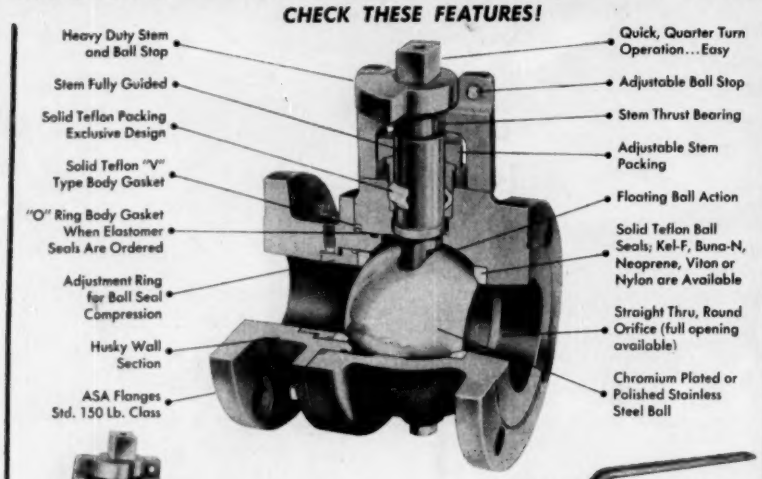
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Solid Teflon "V" Type Body Gasket
"O" Ring Body Gasket When Elastomer Seals Are Ordered
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Husky Wall Section
ASA Flanges Std. 150 Lb. Class
Quick, Quarter Turn Operation...Easy
Adjustable Ball Stop
Stem Thrust Bearing
Adjustable Stem Packing
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Solid Teflon Ball Seals; Kel-F, Buna-N, Neoprene, Viton or Nylon are Available
Straight Thru, Round Orifice (full opening available)
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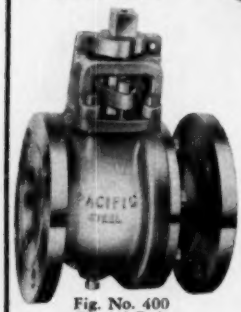

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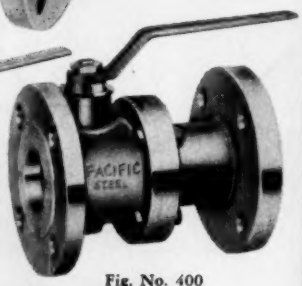

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no trouble reading them and can quickly bring himself up-to-date on the subject. The table of contents for each section is quite comprehensive so that anyone interested in a specific section can quickly locate it. There is a complete bibliography for the articles, with references leading to the original literature. In addition, a comprehensive author and subject index covers the entire book.

This volume is topical now, will remain an excellent reference in the years to come. Anyone interested in advances being made in inorganic chemistry should become familiar with it.

ORGANICS' BULKY BOOKS

PHYSICAL METHODS OF ORGANIC CHEMISTRY. PARTS III & IV, 3RD ED. ED. BY A. WEISSBERGER. INTERSCIENCE.

Reviewed by F. C. Nachod, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

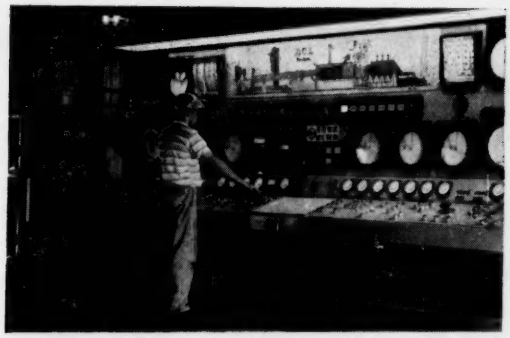
Updating of this tremendously useful text has proceeded at a good rate.

Part III of Vol. I, 3rd ed. (pages 1,799-2,634; $24.50) is devoted mainly to optical methods (exclusive of magneto-optical techniques) and also two chapters on dielectric properties of matter.

Some material from the former edition has been omitted, or included elsewhere in the series; new material (e.g. rotatory dispersion) has been added; and the slate of contributors has changed accordingly.

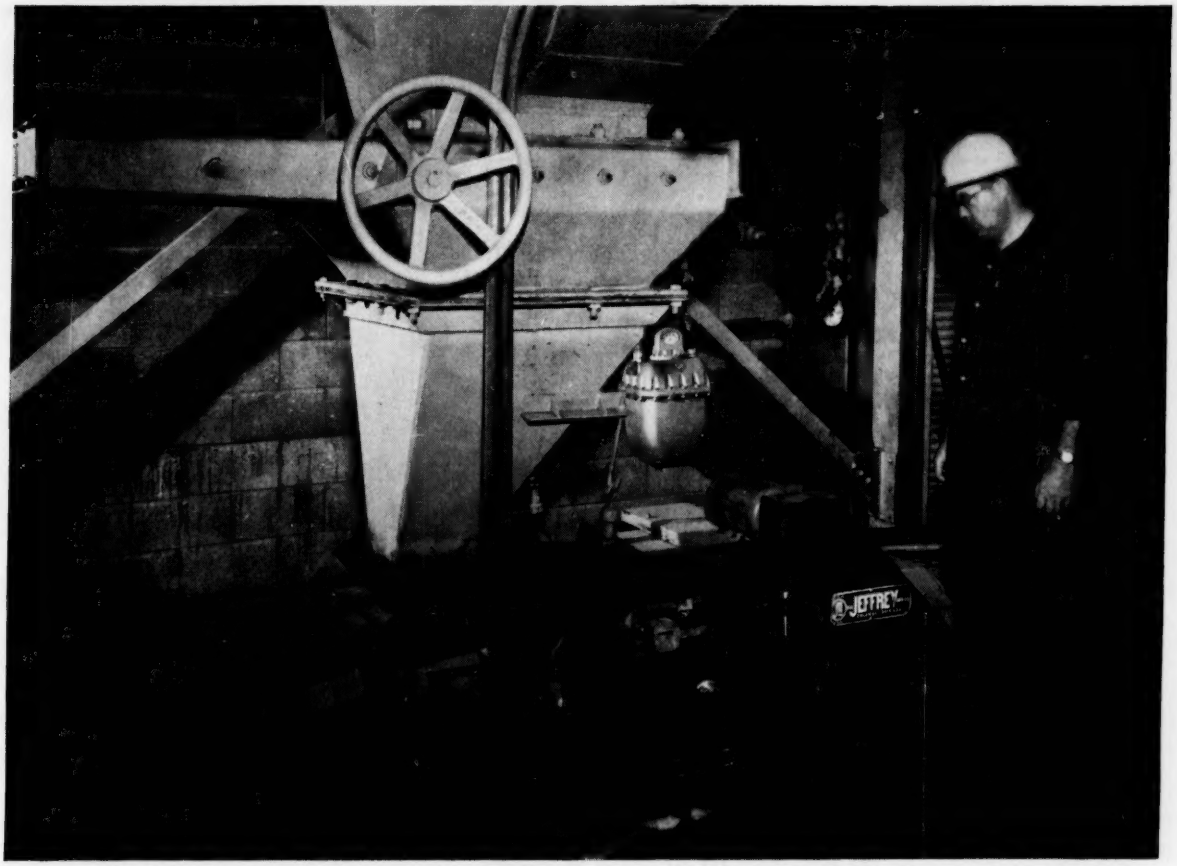
The high standards set in 1946 are maintained. The only concern of this reviewer is where this continued explosion of scientific material and hence published matter will lead with respect to shelf space in his library!

Part IV (pages 2,635-3,539; $24.50) of this fine compendium completes the 3rd ed. of the first volume of a 10-vol. work. It contains 12 chapters of predominantly electronic techniques, such as microwave spectra, NMR, EPR, magnetic susceptibility, potentiometry, conductometry, electrophoresis, polarography, etc. There is much new material, the literature coverage



Centralized controls for kiln and pellatizing grate enable one man to supervise the entire firing system.

Jeffrey WAYTROL® aids in precise control of kiln firing



This Jeffrey WAYTROL meters coal from storage to the crusher; air carries it to the burners in the kiln.

Exact thermal balance makes a difference at Marquette Cement's Milwaukee plant. Recently production was at a record 5,137 barrels per day, yet firing controls are so accurate that fuel consumption ran only 584,750 BTU's per barrel. The key to the operation is a Jeffrey WAYTROL, metering coal to the mill to be ground for burning.

WAYTROLS, working individually or in multiple, weighfeed materials at a constant, predetermined rate. Controls are from a central station, where proportioning can be varied by the turn of a dial.

Catalog 941 describes WAYTROLS and their many interesting uses. For a copy, write The Jeffrey Manufacturing Co., 909 North Fourth St., Columbus 16, Ohio.

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apparently including 1959, which in a multiauthor text is an editorial achievement.

This reviewer like many other readers is much concerned with the "literature explosion" and would like to offer some statistics concerning the evolution of Weissberger's Volume I.

	First Edition	Second Edition	Third Edition
Years	1946	1949, '54	1959, '60
No. of parts	2	3	4
Total pages	1,367	2,530	3,539
Shelf space, in.	2½	5¼	7½
% Growth			
Pages	100	185	260
Size	100	210	300

Now, we do not wish to become embroiled in an argument as to how much of this growth is true scientific development and how much may be a corollary of Parkinson's Law. The time for an abridged Weissberger seems ripe indeed!

And Also Received

Scandinavian Research Guide. A comprehensive two-volume soft-cover, completely in English, that lists over 1,500 research institutions in Norway, Sweden, Denmark, Finland and Iceland. Information includes names of top personnel, size of staff or membership, nature of work, publications issued, and sometimes a very short note regarding contract policy. The guide is completely indexed by science, scientist, type of organization, etc. Price: $10. Write: Scandinavian Council for Applied Research, Gaustadalleen 30, Blindern, Norway.

More New Books

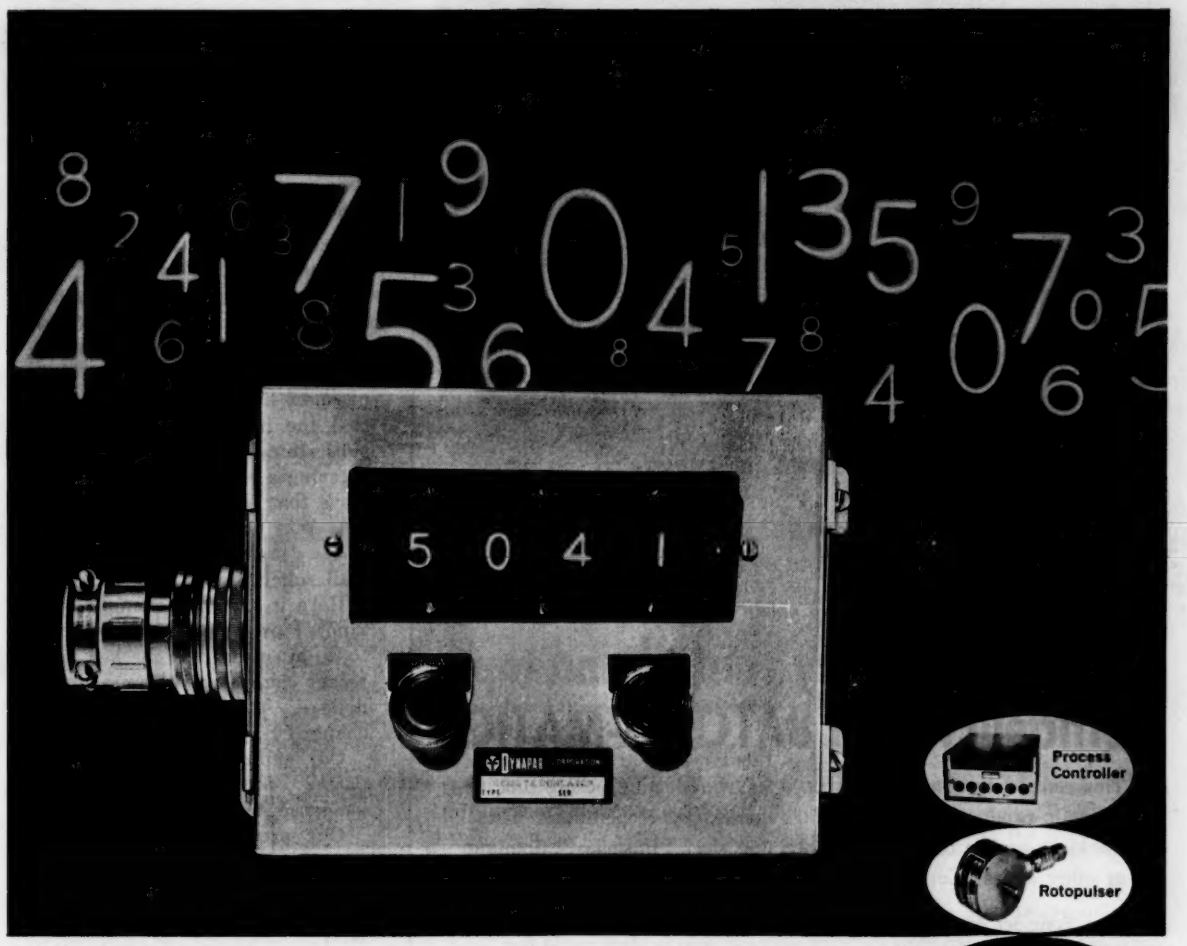
Plasticizers. By D. N. Buttrey. Franklin Publishing Co., Palisade, N. J. $7.50.

Information Retrieval and Machine Translation. Vol. 3, part 1. Ed. by A. Kent. Interscience. $23.

Treatise on Analytical Chemistry. Part 1: theory & practice (vol. 2). Ed. by I. M. Kolthoff and P. J. Elving. Interscience. $16 ($14 by subscription to series).

Scientific Russian. 2nd ed. By J. W. Perry. Interscience. $9.50.

Separation Processes in Practice. Ed. by R. F. Chapman. Reinhold. $4.95.



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*Dynapar Corporation is the electronic subsidiary of The Louis Allis Co.

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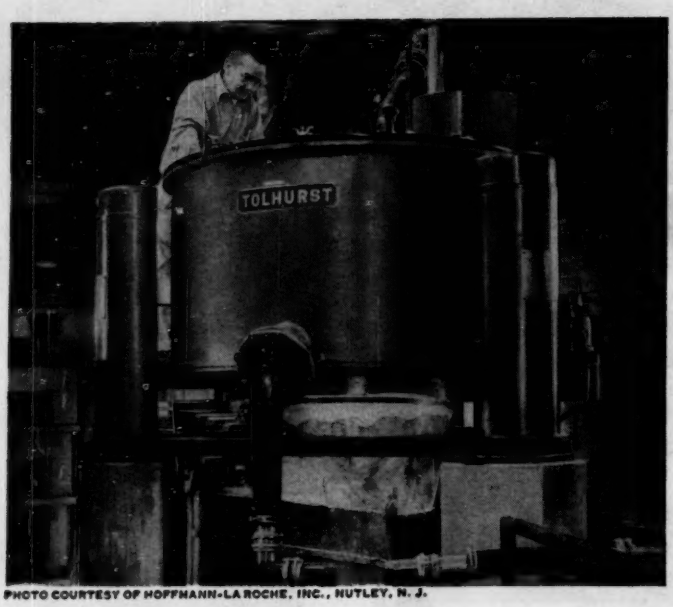

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This completely *automated* BATCH-O-MATIC reduces exposure time to maintain product stability in centrifugal extractor operations. These machines can be constructed of stainless steel, "Hastelloy," titanium or other alloys. Corrosion-resistant coatings may be specified.

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Please send illustrated details on the BATCH-O-MATIC. I'd also like information on TOLHURST manual models ☐.

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Letters: Pro & Con

Dear Readers:

Once in a while, some of you will call our attention to the fact that you receive subscription solicitations even though you already subscribe to *Chemical Engineering*.

Before we enter any name on our prospect list, we first check to see that the individual is not already subscribing to *CE*. Similarly, upon entering a new subscription, we remove that name from our prospect list. Why, then, do we continue to worry present subscribers with mail solicitations?

Here is a classic example of the kind of problem we face. It came to light when we checked out a recent complaint. (Names and addresses, of course, have been changed.)

Our subscriber file showed this listing: John F. Peel, 1776 Independence Ave., White Plains, N. Y.

Our prospect file showed these two listings: John F. Peel, 1492 Columbus Ave., New York, N. Y.; J. Piel, P. O. Box 1066, New York, N. Y.

It turned out, of course, that these three individuals were one and the same. Mr. Peel was receiving his magazine at home but was getting double-barreled mail solicitation at his office.

If Mr. Peel had entered his subscription via the usual application card, we would have had his home address plus at least one of his business addresses. In this case, however, Mr. Peel's subscription was entered via an agency, showing only his home address. And our own filing system is arranged geographically, for mailing purposes, so that we would normally fail to detect duplications across city or state lines.

Now if you are a subscriber to *CE* but get our mail promotion at some other address or under a misspelled name, you can help us correct the situation. Simply tear the address sticker from your *CE* wrapper, clip it to an envelope in which you received a mail solicitation, attach the "order card" and send to me here at 330 W. 42nd

St., New York 36, N. Y. We'll take care of the rest.

LYNN ELLIOTT
Mail Promotion Manager
Chemical Engineering

P. S.—Further investigation of Mr. Peel's case showed that his White Plains (home) address had also been in our prospect file but had been duly removed therefrom when he entered his subscription.

Pro: Government Service

Sir:

I regularly receive requests for information relating to scientific civil service opportunities in the Chemical Corps.

In your May 5, 1958, issue (pp. 161-4) you published an article by Robert R. Freeman on "How Chemical Engineers Serve Uncle Sam." This article has been brought to my attention as a suggested source of information to answer requests for information. I would therefore like to have permission to reproduce this article for installation use by my office and the civilian personnel department.

JOHN C. WALL
U. S. Army Chemical Center
Army Chemical Center, Md.

Pro: Isocracking Process

Sir:

We are greatly concerned that in your review of New Processes and Technology in your Jan. 23 issue (pp. 121-30) you omitted mention of the Isocracking process. Two competitive hydrocracking processes were each mentioned twice.

Isocracking is the recognized leading process in the field in view of the operating plant in Socal's Richmond refinery, and announcements last year of a 7,500-bbl./day Isocracker at Toledo for Sohio and a 20,000-bbl./day Isocracker to be built at Avon, Calif., by Tidewater Oil Co. By way of comparison, there are no announced commercial units for Unicracking and only one small 2,000-bbl./day unit for Lomax.

We think that isocracking de-

NIAGARA VERTICAL FILTER AT KIND AND KNOX GELATIN COMPANY, CAMDEN, N. J.

"In half the time needed by our old filter press, we can run a batch of gelatin in the thin liquor stage through our new NIAGARA VERTICAL FILTER," says Edward Bohn Jr., assistant plant superintendent for one of the largest U. S. gelatin producers.

Remarkable reductions in down time and labor costs also are reported by Kind and Knox with its new NIAGARA FILTER. "Resetting the NIAGARA for a new run takes one-fourth the time and one man can handle the procedure without a helper," Bohn says. "Our regular filter press requires two men working two hours to change 50 filter cloths. With NIAGARA, hot water under pressure completely removes the residue in minutes, and the unit does not have to be opened. Also, there are no filter cloths to clean or replace in our NIAGARA FILTER."

The plant operates 24 hours a day, 7 days a week, and to date there has been no operational trouble with the NIAGARA FILTER. This compact filter has a base measurement of only 52" x 102", so there is a big savings in floor space.

For details on how custom engineered NIAGARA FILTERS can help with your processing problems, write for bulletin NC-457, or see the NIAGARA section in Chemical Engineering Catalog.

Niagara® FILTERS

A DIVISION OF

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Entire half of cone comes off . . . not just an access door . . . exclusive feature

While the DE BOTHEZAT® Bifurcator® **remains in the duct,** this new design duct fan provides an **easier, quicker** way to remove the fan wheel or motor . . . **speeds up** periodic inspections of fan wheel, bearings and extension shaft. The entire half of the cone unbolts and comes off, allowing plenty of room to work.

dependable . . . easy to install

Installation is as fast and simple as putting in a section of ductwork. DE BOTHEZAT direct drive motor, completely isolated from fumes and heat, insures steady, trouble-free operation over long periods. Ideal for handling corrosive fumes.

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serves the same notice as the other processes in this and in future reviews.

W. H. CLAUSSEN
California Research Corp.
San Francisco, Calif.

▶ *These reviews are designed to be additive, not cumulative. In our May 2, 1960, review, Isocracking was appropriately mentioned because it was announced or became commercial during the calendar period then under review. Each new commercial unit, of course, is listed in our periodic reviews of New Plants & Facilities. Both the Sohio and Tidewater units are slated to be listed in our Apr. 17 review.*—ED.

Inappropriate Picture

Sir:

I was particularly interested in the picture that accompanied your story, "Nylon Gains in Tire-Cord Fray," part of your Forecast for '61 (Jan. 9, pp. 86-7).

If memory serves me correctly, this picture was taken on the test track of the U.S. Rubber Co. in California and was used primarily to promote the steel shield tire that this company introduced to the truck tire trade several years ago. I covered that story at the time as an editor; my observation was that it was the steel shield in the tire, rather than the basic cord structure, which the company was attempting to promote. (*continued*)

WE GOT OUR FEET WET 4 BILLION BARRELS AGO

4,000,000,000 barrels of oil (even greater quantities of chemicals) have gushed, gurgled, surged, spurted and, in some cases, oozed in precise response to Autronic® control loop signals.

There have been remarkably few troubles reported. In the beginning, of course, there were the inevitable design bugs. But now, 20,000 loops later, the bugs have all been worked out.

As a result, when you specify Swartwout, you get instrumentation that has shown—on the job—that it can do the job. You get all the advantages of electronic controls and the assurance and security that only a decade of field operation can provide.

Swartwout people know electronic instrumentation, and they would be glad to share that knowledge with you.

Interested? Send for Bulletin A-913.

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What are you paying for SPRAYING?

EXAMPLE:
Spraco Full-Cone Free-Flow Nozzles — for high capacity, low pressure installations

Spraco full-cone, free-flow nozzle discharging 860 gpm at 5 psi. At this shutter speed (1/5,000 sec.) pump pulsations are apparent in the spray pattern

To answer a long felt processing need, Spraco recently developed a totally new line of full-cone, free-flow nozzles for high capacity, low pressure installations where clogging is a problem and a full-cone spray a necessity. Featuring streamlined internal vane construction with maximum vane openings, they offer minimal flow resistance, virtually eliminate clogging.

Now widely used in cooling towers, coke quenching, aerating and purifying water supplies, and a host of chemical processing applications, Spraco Full-Cone Free-Flow nozzles are another excellent example of how Spraco cuts the cost of spraying by increasing the efficiency of the system.

What's your spray nozzle problem? Spraco offers the most complete range of nozzle sizes and capacities available anywhere, always in stock, and made from bronze, cast iron, stainless steel, or, to order, from any special machineable material.

Write today for the most comprehensive spray nozzle catalog ever published. Complete, accurate performance data for each of the hundreds of spray nozzles in the line.

SPRAY ENGINEERING COMPANY, *115 Cambridge Street, Burlington, Mass.*

SPRACO

PRO & CON . . .

In this connection, there is an increasing demand among truckers around the country for tires made with Tyrex rayon tire cord. The performance of these truck tires made with Tyrex cord is proving itself daily. So much so, in fact, that a number of trucking concerns have changed from a predominant nylon tire-cord picture to one where Tyrex rayon tire cord is now in heavy demand.

As a result, we are confident that the outlook for Tyrex rayon tire cord is not nearly as bleak as many prophets might suggest.

PHILIP E. ROBINSON
Tyrex Inc.
New York, N. Y.

Student Chapter Head

Sir:

In the biographical sketch following my article on "Sound Suppression in the Chemical Process Industries" (Feb. 20, pp. 127-34), there is a statement that may lead your readers to believe, falsely, that I am currently, or have been in the past, national president of Alpha Chi Sigma. The fact is that I was president of a chapter of this organization while pursuing my education at M. I. T.

I am otherwise quite pleased with the format of this article and am happy to have it appear in your fine magazine.

ROBERT L. JACKS
M. W. Kellogg Co.
New York, N. Y.

Pro: Richardson Series

Sir:

Congratulations on the Jan. 9 article (pp. 124-128), "Manufacturing: Is It Art or Science?" When can we look forward to more such articles by Mr. Richardson?

L. E. O'ROURKE
Melpar, Inc.
Falls Church, Va.

► *Consultant Richardson has promised us several more articles dealing with various aspects of plant operation and maintenance.*—ED.

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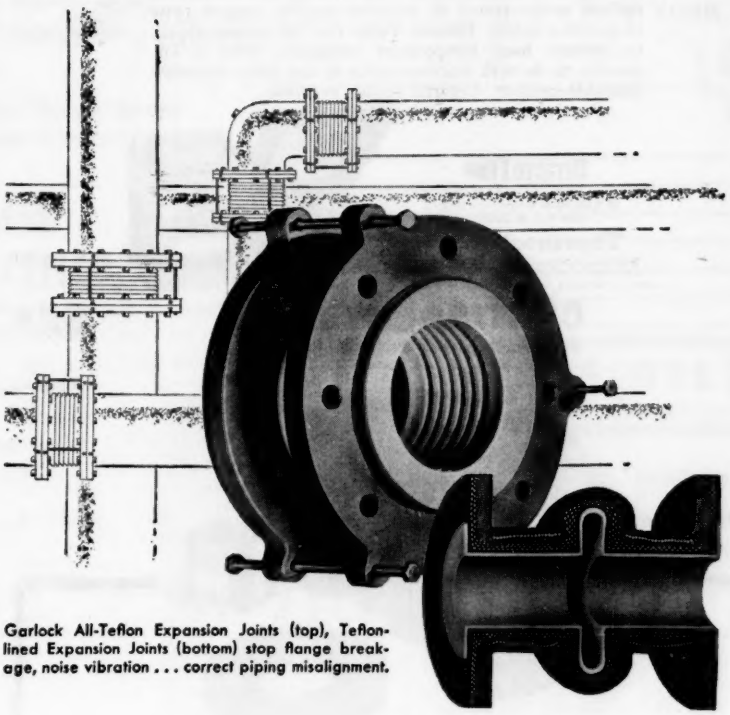
for Chemical Processing



Garlock All-Teflon Expansion Joints (top), Teflon-lined Expansion Joints (bottom) stop flange breakage, noise vibration . . . correct piping misalignment.

Under constant attack from the most reactive chemicals, Garlock Teflon* Expansion Joints give top protection to expensive piping.

Ideal for fluid process piping handling solvents, acids, and caustics, Teflon Expansion Joints act as a cushion to absorb pump, compressor, engine and pressure surges. This prevents stress, compensates for misalignment, reduces flange breakage . . . your piping lasts longer, your maintenance is cut drastically.

For service to 75 p.s.i., Garlock All-Teflon Expansion Joints are recommended. Consisting of a Teflon bellows with several convolutions, the joints are so designed as to completely shield the flanges; they are furnished with built-in compressible gaskets to contact the face of the metal retaining flanges. No adapters or additional gaskets are required. Garlock All-Teflon Expansion Joints are available in standard sizes for a wide range of pipe diameters and face-to-face working limits.

For service to 150 p.s.i., Garlock Teflon-lined Expansion Joints are suggested. These consist of a spool-shaped Teflon liner backed up by a spool-type expansion joint made of rubber and cotton duck and reinforced with steel rings. The Teflon is made to the same I.D. as the pipe, completely lines the inside of the joint, and is embedded in the joint faces inside the bolt holes. Available for prompt delivery in pipe sizes up to 8″ diameter. Other sizes on order.

For complete pipe protection, Garlock also furnishes All-Teflon Flexible Couplings, and All-Rubber Expansion Joints. For the type best suited to your needs, consult your local Garlock representative. He's at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-137, Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

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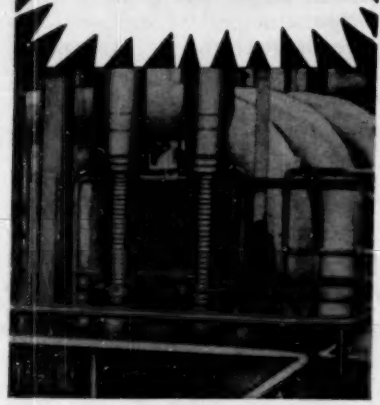

FLEXIBLE METALLIC TUBING ABSORBS STEAM RELEASE SHOCK

Shock, expansion, temperature, pressure all suddenly combine to liberate steam at 900°F. and 850 psi. The expansion joints get the full impact as the blow-off valves release the steam. No place for a weak-kneed joint. That's why the operator in this large power plant installed Penflex stainless steel interlocked (8" I.D.) expansion joints.

Penflex Expansion Joints are dependable because they have been tested and proved to be strong, tough and flexible enough to stand the shock, pressure and thermal expansion. This is just one of the hundreds of "job-proved" applications of Penflex expansion joints. Proper selection and application of flexible tubing is assured with Penflex "Flexineering" . . . a service that is yours to assure you of more efficiency on each installation. Write today for "Flexineering" data book and catalog to **Pennsylvania Flexible Metallic Tubing Co., Paoli, Pa.**

Penflex

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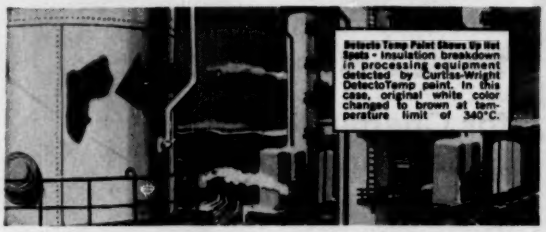
Color-Changing Paint Indicates Temperatures — Thermal Distribution


Detecto Temp Paint Shows Up Hot Spots • Insulation breakdown in processing equipment detected by Curtiss-Wright DetectoTemp paint. In this case, original white color changed to brown at temperature limit of 340°C.

Detectotemps are temperature indicating paints which change from one color to a totally different color when certain temperatures are reached. They are used in hundreds of operations from chemical processing, petroleum refining to welding, forging, heat treating and monitoring surface temperatures to improve quality, reduce costs or increase safety. Detecto Temp has the unique ability to indicate local temperature variations. This is impossible to do with thermocouples or any other presently available product. Colorful folder available.

DETECTO TEMP

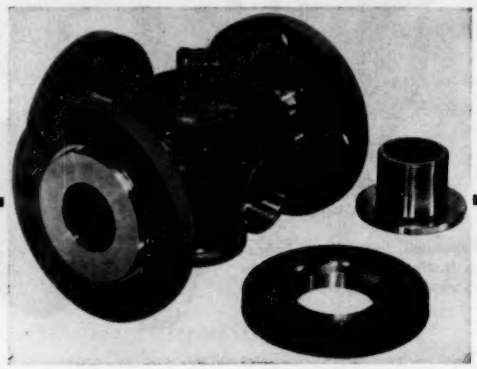
Paint available in 4 oz. and 1 lb. metal cans. 36 types cover temperature range from 40°C to 1350°C

Thermochrom

Crayons convenient for testing surface temperatures of small areas. 18 crayons cover temperature range from 65°C to 670°C.

CURTISS WRIGHT

Princeton Division • Princeton, New Jersey



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Chemicals

Activated Carbon.....A complete line of activated carbons for every purpose. Design and prefabricate complete purification, separation & recovery systems. Bul. J-103.
230 *Barneby-Cheney

Additives..... Paradyne HO-10 and Paradyne HO-20 may be added to heating oil at any point in the distribution system. Further information is available.
12-13 *Enjay Chemical Co.

Ammonia.....Brochure describes the production of ammonia via steam reforming, includes direct operating costs and utility unit costs in five major geographical sections.
230A M. W. Kellogg Co.

Beta Resorcylic Acid..... a versatile starting material for the preparation of commercial organic compounds, is available from plant production. Information.
8-9d *American Cyanamid Co.

Black Polyethylene Resin.....for extrusion coating onto paper, paperboard or aluminum foil. Expected to find application in a wide variety of products.
37-38a *U. S. Industrial Chemicals

Calcium Hydrides..... dry materials completely in gas or liquid phase. Details on complete drying with calcium hydride are contained in a new bulletin.
99 *Metal Hydrides Inc.

Catalysts.....Aerocat 3C catalysts give refiners more flexible and profitable operations. These three component catalysts yield more gasoline, propylene, etc.
8-9a *American Cyanamid Co.

Caustic Soda.....40-page booklet gives chemical and physical properties and includes special section on determining costs of caustic shipments. Includes first aid procedures.
230B U. S. Industrial Chemicals Co.

*From advertisement, this issue

Chemicals Catalog ..... New catalog lists over 100 surfactants and specialty products for the industrial and textile trade. Specific applications and general use suggestions given.
231A Onyx Chemical Corp.

Chemical Grout ..... AM-9 chemical grout changes the earth's consistency. The powdery chemical may be dissolved in water right at the construction site. Information.
8-9b *American Cyanamid Co.

Chemicals ..... A reliable source of supply for high purity naphthalene and bezene as well as such chemicals as toluene, xylene & heavy aromatic concentrates.
101 *Ashland Oil & Refin. Co.

Diatomite ..... Celite offers constant uniformity in every grade to assure constant results and less downtime. Many different grades of Celite are produced. Information.
128 *Johns-Manville

Elastomer.....Viton synthetic rubber offers outstanding resistance to oil, fuels, solvents, and chemicals. Specific data on the heat & fluid resistance of this new elastomer.
58 *E. I. Du Pont

Filter Fabrics ..... offer maximum chemical and heat resistance, high abrasion resistance, and efficient cake retention-and-discharge properties.
232 *United States Rubber

Filter Paper.....custom-tailored to your process & your press. A 24-page catalog on industrial filter papers gives complete details. Catalog 357.
122 *Eaton-Dikeman Co.

Fluorocarbon Resins.....Teflon resins are rated for continuous service at 500 deg. F. Can be molded & extruded like other resins. Additional information is offered.
97 *E. I. DuPont de Nemours

Furfural.....for new product or new process development. Additional information plus physical data on Furfural is contained in Bulletin 203-A which is offered.
85 *The Quaker Oats Co.

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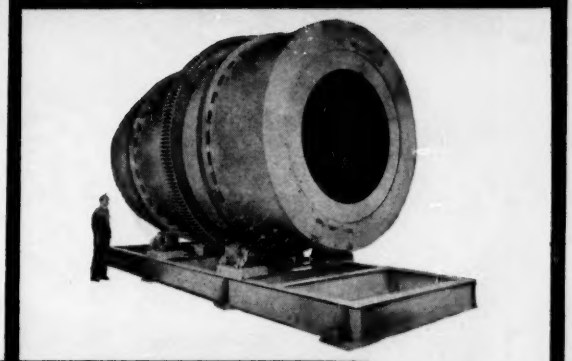

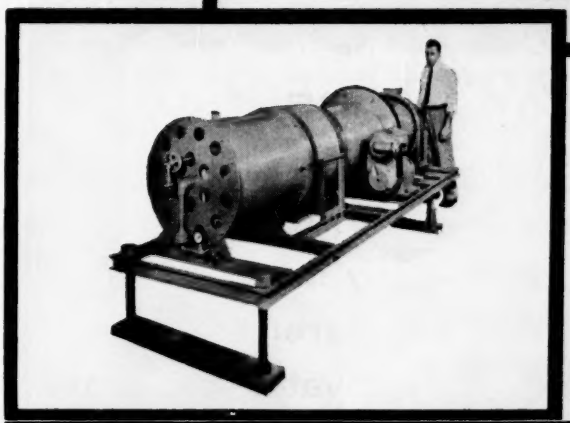

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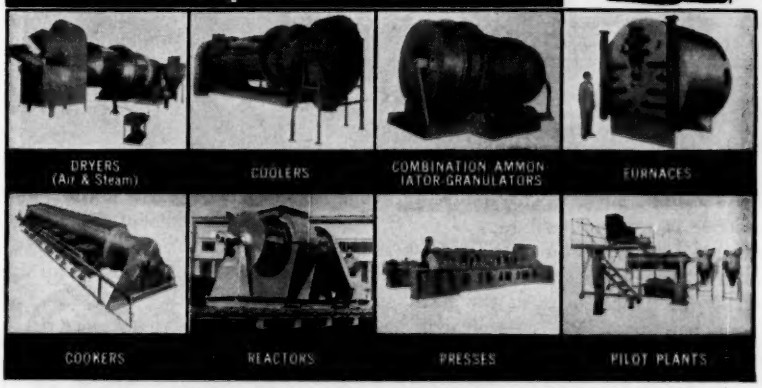

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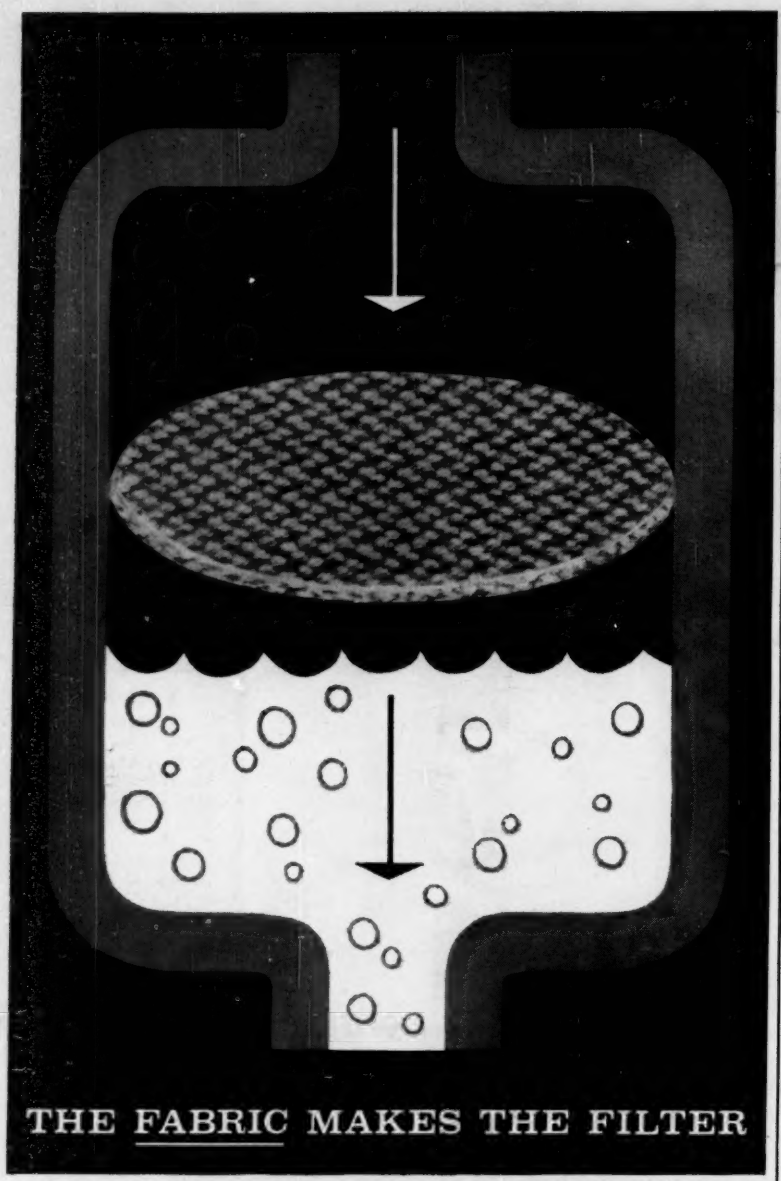

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LITERATURE . . .

Fused Quartz.....Vitreosil has extreme heat resistance. Available in many types & sizes. Also fabricated to your special needs. Complete, illustrated catalog.
R256 *Thermal American Fused Quartz Co.

Hydroxamic Acids.....New fatty hydroxamic acids have reactive OH and NH group as well as long, straight chain fatty group. Information is available on request.
37-38g *U. S. Industrial Chemicals

Lactonitrile.....is an inexpensive, bifunctional raw material. Converts to a host of useful intermediates. A technical booklet is offered for the full story.
8-9c *American Cyanamid Co.

Liquid Hydrogen.....Hazards of producing and storing liquid hydrogen and safer ways for handling this high-energy fuel are covered in technical publication No. 5707.
232A Bureau of Mines

New Products.....Pamphlet contains data on 12 new products that offer opportunities for improved performance in applications requiring resistance to corrosion, abrasion etc.
232B The Carborundum Co.

Phospholeum ..... superconcentrated phosphoric acid offers many advantages. Can be supercooled for days without crystallization. TDS I-210 contains complete technical details.
49 *Monsanto Chemical Company

Pigment Extender.....Technical bulletin describes "Micro-Cel T-38" a synthetic, hydrous calcium silicate that displays remarkable hiding power at low concentration.
232C Johns-Manville Corp.

Resin.....20-page booklet on Marvinol VR-50 describes how this allpurpose, stir-in-paste-grade resin is used in plastisol and organisol applications.
230D U. S. Rubber Co.

Silicone Defoamers.....Job-proved thousands of times as the most efficient, most economical and most versatile foam suppressors available. Manual is offered.
R243 *Dow-Corning Corp.

Temperatures Indicating Paints..... DetectoTemps change from one color to a totally different color when certain temperatures are reached. Colorful folder available.
TR228 *Curtiss Wright

Construction Materials

Aluminum Conduit.....solves most corrosion problems in and around chemical plants. It's lightweight, nonmagnetic and nonsparking. Additional information available.
22-23 *Rome Cable Div. of Alcoa

Ceramic Catalyst Carriers.....Size, weight, porosity, & purity are held to close tolerance. Carriers are described in detail in bulletin "Keys to Better Catalysis".
55 *Norton Company

Coatings.....Kel-F dispersion coatings resist sticking and resist chemicals. May be applied to most metals that can stand approximately 500 deg. F. Tech. data.
209 *Minn. Mining & Mfg. Co.

*From advertisement, this issue

Fabrication.....from assignments of towering proportions to smaller jobs of the most intricate design. A resume of Boardman capabilities is available on request.
167 *The Boardman Co.

Fabrication.....Sheet metal and alloy components, weldments and plate work, custom fabricated. A 40 page catalog on fabrication is available on request.
202 *Kirk & Blum Mfg. Co.

Felt Applications.....Proven solutions to a range of engineering & design problems pack the pages of the A+ Felt Applications Guide. Bulletin 8-60 is also available.
TL247 *American Felt Co.

Packings.....Direct-cooling designs take heat off high pressure packings. Keeps cool even at pressures up to 50,000 lbs. per sq. in. Information is available.
124 *C. Lee Cook Div.

Reagents.....for paper chromatography and electrophoresis are now available. Free operator from dependence on air pressure lines. In 200 ml aerosol spray bottles.
37-38c *U. S. Industrial Chemicals

Rupture Discs.....Model CPV is designed for low pressure application while Model HOV is designed to operate closer to rupture pressure. Catalog is offered.
L257 *Fike Metal Products Corp.

Stainless Steel.....ELC stainless steel reduces first cost of corrosion-resisting equipment and keeps maintenance expenses at a minimum. Data is offered.
199 *Armco Steel Corp.

Vinyl Coatings.....Brochure provides coatings formulator with basic information on general properties and uses, formulations and preparation of clear and pigmented coatings.
233A Union Carbide Plastics Co.

Wire Cloth.....Whatever metal or alloy needed in any size or quantities to the closest tolerances. High mesh counts are featured. An illustrated 120 pg. catalog.
138 *The Cambridge Wire Cloth Co.

Wire Cloth & Screen.....woven from s. steel, Monel, bronze, copper, brass, high carbon & oil-tempered steel & virtually any metal that can be drawn into wire. Cat. 105.
214 *Ludlow-Saylor Wire Cloth Co.

Electrical & Mechanical

Couplings.....Bulletin 4100 presents complete line of companies torsionally resilient Steelflex couplings. Charts and tables contain up-to-date engineering data.
233B The Falk Corp.

Enclosures.....Spin Top enclosures are available in three ways: complete device, enclosure only, or components only. Details in Bulletin 9990.
169 *Square D Company

Expansion Joints.....Catalog AD-137 contains information on solid teflon and teflon-lined expansion joints for chemical processing applications.
225 *Garlock Inc.

*From advertisement, this issue

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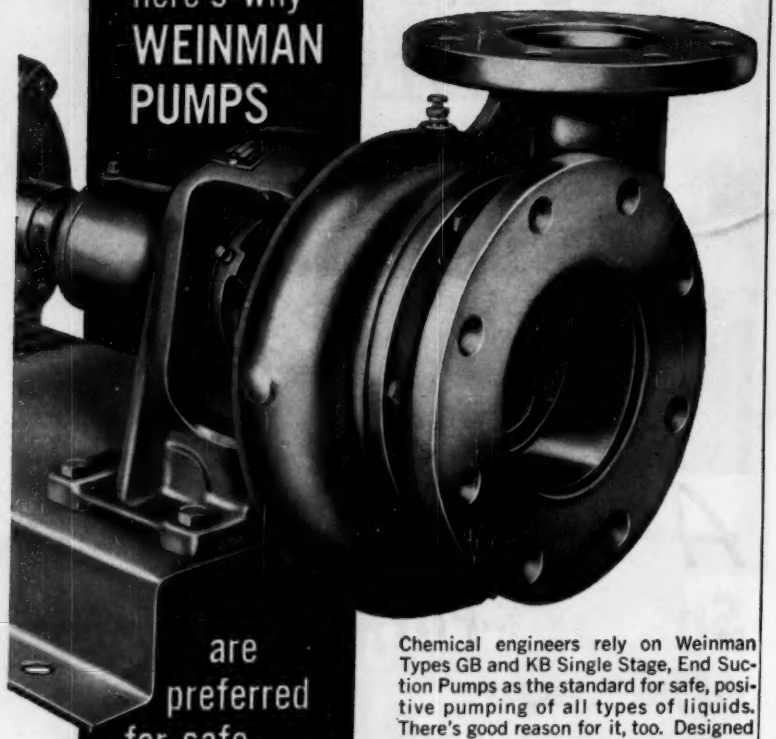

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swift
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corrosive
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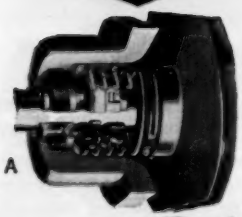
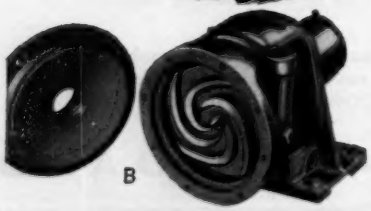


A

. . . for example, this special shaft seal (shown at left . . . A) stops chemical leakage; reduces fire hazards; eliminates fumes and cuts waste.



B

. . . and this open type impeller (shown at left . . . B) available for every size pump, speeds pumping of liquids with suspended foreign matter.

If you have a touchy chemical pumping problem... consult your Weinman Specialist. You'll find him in the Yellow Pages. Chances are he can recommend a standard pump that meets your precise need. If not, we'll work with you in solving your problem. Or write us direct for Bulletin 500.

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LITERATURE . . .

Lighting Fixtures.....Details on mercury vapor explosion-proof fixtures for hazardous areas, as well as a full complement of accessories including mountings, reflectors, etc.
1 *Appleton Electric Co.

Lighting Fixtures.....Catalog covers lighting for every need: bench, area, flood; incandescent, fluorescent, mercury vapor; permanent, portable.
74 *Crouse-Hinds

Mechanical Seals.....Type U mechanical seals require almost no maintenance. Used in all industries and for all applications. Further information is available.
212 *Borg-Warner

Multi-Speed Motors.....4-page bulletin discusses principal types; variable-torque, constant-torque and constant-hp. Polyphase and single phase motors are also discussed.
234A Century Electric Co.

Rectifiers.....as well as complete semiconductor power conversion equipment and systems for any AC to DC application. "Guide" to Industrial Rectifier Equipment.
53 *The Meaker Co.

Speed Variator.....Bed plaste assemblies give precision control of infinitely variable speed output. Complete engineering information in Bulletin 275.
63 *Cleveland Worm & Gear

Handling & Packaging

Air Conveyance Systems.....Flo-Tronics Fluidazation systems—complete or in components can be custom-built to your specifications. Engineering evaluation available.
242 *Flo-Tronics Inc.

Conveying Systems.....Pneumatic conveying systems increase production, cut contamination. For handling dry, bulk or granular materials. Information.
116 *Fuller Company

Conveyor.....Bulletin shows practical profit making uses of totally enclosed bulk handling conveyor that features a two-directional chain to convey materials in any direction.
234B Prab Conveyors, Inc.

Conveyors.....Catalog 858 includes operations, types, drives, advantages, characteristics and gives much more information concerning mechanical vibrating conveyors.
234C Jeffrey Mfg. Co.

Conveyors, Airstream.....A new 32 page brochure presents detailed information on how these conveyors solve bulk materials handling problems. Bulletin 530.
68 *Dracco, Div. of Fuller Co.

Industrial Weighing Equipment..... Information on the full line of industrial weighing equipment from 1/100 oz. to 100 ton is available on request.
BR260 *Detecto Scales, Inc.

Package Casings.....8-page folder describes thirteen automatic and semiautomatic caser models; set-up machines, loaders and sealers are included with floor plan drawings.
234D Food Machinery & Chemical Corp.

*From advertisement, this issue

Remote Handling.....Illustrated 20-page booklet describes manipulator-equipped vehicle systems for remote handling operations, and discusses manned and unmanned systems in use.
235A General Mills

Screw Elevator.....Rotor Lift features compact, single leg design which saves space & avoids large openings in overhead floors. Engineering Catalog is available.
L210 *Southwestern Supply & Machine

Tank Handbook.....A reference and data handbook published by the National Wood Tank Institute containing tables and facts for engineers is available.
193b *Wendnagel & Co., Inc.

Weigh-Feeding Equipment.....Waytrol automatically proportions & feeds raw materials. Catalog 941 describes this automatic weigh-feeding equipment.
217 *The Jeffrey Mfg. Co.

Wood Tanks.....Factual bulletins of importance to tank buyers on corrosion, comparative costs, thermal qualities & maintenance costs. Ask for NWTI set.
193a *Wendnagel & Co., Inc.

Heating & Cooling

Combustion Units.....Now available is the improved Model CP vertical oil firing combustion unit. Ideally suited for use with stills, heaters, etc. Literature.
39 *National Airoil Burner

Contact Cooler.....Highly efficient transfer of heat from the discharged lime to the combustion air, while rapidly lowering lime temperature.
36D *Kennedy Van Saun Corp.

Cooling Tower.....Series 14 double-flow Aquatower offer top performance at absolute economy. A complete line of towers ranging from packaged units to giant size.
203 *The Marley Company

Coils, Smooth-Fin.....offer greater heat transfer per sq. ft. of face area and lower airway resistance—less power per c.f.m. Further details in Bul. S-55.
235 *Aerofin Corp.

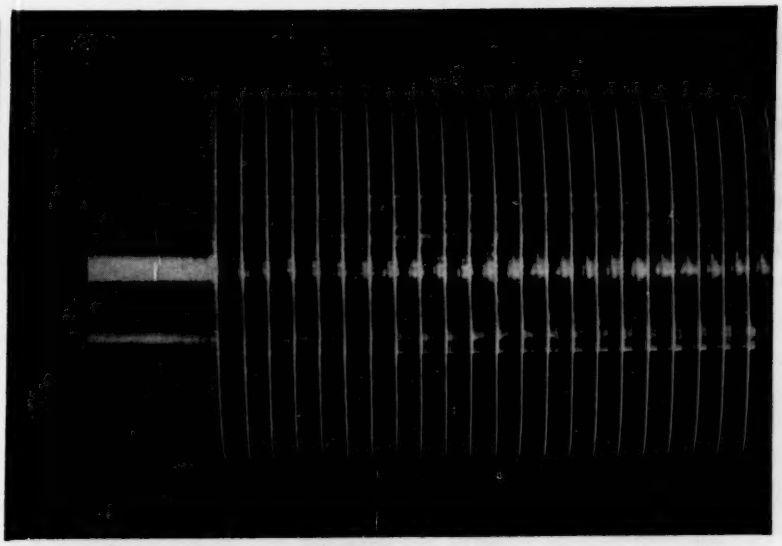
Gradiation Heating.....for batch processing of heavy lubricating greases cuts time, labor and fuel costs 50%. Details are available on request.
R259 *Selas Corp of America

Heat Exchanger.....Karbate impervious heat exchanger offers unsurpassed corrosion resistance, high thermal efficiency, compact design. Bul. S-6813.
95 *National Carbon Co.

Heat Exchangers.....Self-cleaning titanium heat exchangers retain high heat transfer indefinitely. Performance data & facts on history of titanium heat exchangers.
66 *Titanium Metals Corp.

Heat Exchangers.. ....This light & compact heat exchangers surface is being used in more & more installations where superior performance is essential. Information.
26-27 *Trane Co.

*From advertisement, this issue

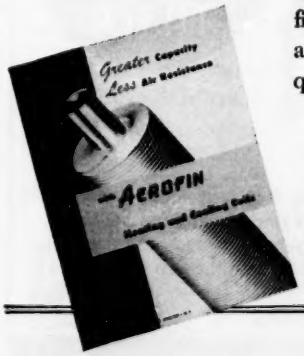


AEROFIN
Smooth-Fin Coils
offer you

Greater Heat Transfer
per sq. ft. of face area

Lower Airway Resistance
—less power per c.f.m.

Aerofin smooth fins can be spaced as closely as 14 per inch with low air friction. Consequently, the heat-exchange capacity per square foot of face area is extremely high, and the use of high air velocities entirely practical. Tapered fin construction provides ample tube-contact surface so that the entire fin becomes effective transfer surface. Standardized encased units arranged for simple, quick, economical installation.



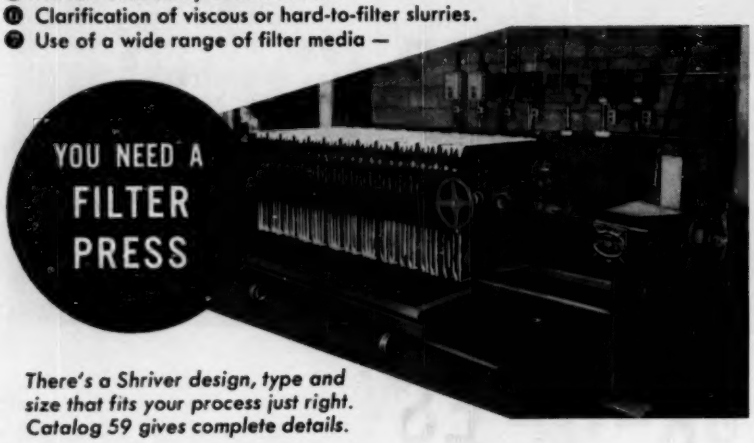
AEROFIN CORPORATION
101 Greenway Ave., Syracuse 3, N. Y.

Write for Bulletin S-55

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

WHEN YOU REQUIRE FILTRATION

❶ That is versatile and flexible in operation,
❷ Over a wide range of pressures,
❸ For recovery of filtrate and of uniform, dense filter cake,
❹ With effective washing or extraction of cake.
❺ No left-over slurry at end of run.
❻ Clarification of viscous or hard-to-filter slurries.
❼ Use of a wide range of filter media —



There's a Shriver design, type and size that fits your process just right. Catalog 59 gives complete details.

WHEN YOU REQUIRE FILTRATION

❶ Of slurries with a low percentage of compressible and disposable solids or
❷ Of slurries with up to 15 percent of solids, with either or both filtrate and solids to be recovered.
❸ Where continuous filter aid additions are required to maintain a permeable filter cake.
❹ Where residual solids may be reslurried with water for disposal.
❺ Where an enclosed tank is needed to avoid leakage.
❻ With one-man operation for sluicing, cleaning and preparation for the next cycle —

The Shriver vertical leaf filter is available in vertical tank and horizontal tank types, in a wide range of leaf and tank sizes. New Bulletin 150 tells the story.

FILTERS AND COMPLETE FILTER STATIONS TO MEET YOUR EXACT PROCESSING NEEDS

T. Shriver & Company, Inc.
802 HAMILTON STREET • HARRISON, N. J.
Sales offices in principal cities

LITERATURE . . .

Heat Recovery Systems.....Bulletin TKB-3 describes these unexcelled heat recovery systems and the many outstanding features that they offered.
50a *Traylor Engineering & Mfg.

Heat Transfer.....Platecoil provides a packaged answer to many heat transfer problems, avoiding costly engineering and fabricating of pipe coils. Bulletin P61.
56 *Platecoil Div., Tranter Mfg. Inc.

Heating & Cooling Equipment.....Catalog shows equipment for homogenizing, heating, cooling, flavoring, storing, separating, freezing, mixing, packaging, etc.
115 *Cherry-Burrell Corp.

Kilns.....Thorough, experienced attention to engineering details produce kilns that are notable for continuous service. Further information in Bulletin 1115.
50b *Traylor Engrg. & Mfg. Co.

Make-Up Air Systems.....Fans bring in outside air, and heaters temper it. Cancels out vacuum, gives balanced heat & ventilation. A booklet is available.
171 *Sturtevant Div., Westinghouse

Package Refrigeration Units.....Both packaged cooling units & packaged compressor units for use with remote heat exchangers are available. Bulletins (820,427) offered.
239 *The Vilter Mfg. Co.

Short Rotary Kiln.....makes long kilns unnecessary. There is less kiln to buy and maintain; there is less brick—fewer foundations. Further particulars are offered.
36Db *Kennedy Van Saun Corp.

Steam Generators.....Bulletins describing Vogt boiler installations in a variety of industrial plants for power, processing & heating are available on request.
140 *Henry Vogt Machine Co.

Steam Traps.....Series 30 is the steam trap for peak efficiency. Series 130 combines a Series 30 trap, a strainer & blow-down valve. New bulletin T-1743-B offered.
67 *Yarnall-Waring Co.

Stone Preheater.....puts the kiln exit gases to work to partially calcine feed. Makes the rotary kiln the most economical producer of high quality lime.
36Da *Kennedy Van Saun Corp.

Temperature Controls.....A handy, condensed catalog of the complete line of temperature controls & allied equipment for industrial heating & refrigeration.
45 *The Partlow Corp.

Vapor Condenser.....The Aero Vapor Condensers are manufactured in standard units in a range of capacities up to thirty million Btu's. Bulletin 129-R.
TR260 *Niagara Blower Co.

Instruments & Controls

Amino Acid Analyzer.....is described in new brochure. Gives features and use of instrument for automatic analysis of protein and peptide hydrolyzates, etc.
37-38f *U. S. Industrial Chemicals

*From advertisement, this issue

Analyzers.....Model G-2 or F-3 continuous analyzers dependably monitor oxygen determinations in any range from 0 to 100%. Further details in Data File 14-12-08.
51 *Beckman Instruments Inc.

Controller ..... Dynalog Controllers have no slidewires, no galvanometers, & no balancing motors. Nothing to wear out or get out of alignment. Details in Bul. 20-10.
139 *The Foxboro Co.

Controller.....PowrMag system is based on the analog computer approach to process control. Components are interchangeable. Further information is available.
91 *Hagan Chemicals & Controls

Data Processing System.....The new B5000 information processing system offers large scale performance in the medium price range. "The B5000 Concept" is offered.
6-7 *Burroughs Corp.

Digital Control System.....Dynapar digital control is a highly accurate Digital logic system. It can count, measure, totalize, indicate and time. Information.
219 *The Louis Allis Co.

Gages and Valves.....Features and specifications of Jerguson high pressure boiler water gages and valves are covered in data sheet No. B93. Sizes to 18" and WSP to 1,500 lb.
237A Jerguson Gage & Valve Co.

Gauges.....The unique Maxisafe Duragauge provides absolute protection to the viewer plus easy & quick access to the mechanism. Catalog 300B.
131 *Manning, Maxwell & Moore

Gauges & Thermometers.....A condensed catalog is available showing various pressure gauges and gauges and thermometers for any necessary purpose.
237B Marshalltown Mfg. Co.

Instruments.....Compact Metagraphic instruments are ideal for graphic panel use or where true plug-in versatility is necessary. The complete story is offered.
60 *Bristol Company

Instruments.....Instrumentation that has shown that it can do the job. All the advantages of electronic controls with assurance and security. Bulletin A-913 available.
223 *Swartwout Div., Crane Co.

Instruments.....feature plug-in components for continuous control and quick conversion. Offer faster installation, interchangebility of instruments, etc.
118 *Taylor Instruments Co.

Kiln Control.....A single, attractive cubicle houses all instruments essential to control system. Each factory assembled and checked. Particulars are available.
36Dc *Kennedy Van Saun Corp.

Liquid Level Gauge.....Operation and Unique features of this electrically powered tank gauge, which is calibrated to 1/16 inch, are included in 4-page bulletin No. CP3709.
237C The Vapor Recovery Systems Co.

Magnetic Gage.....features a safety design which seals against escaping gases. Measuring mechanism is in stainless steel chamber. Engineering sheet available.
R247 *Jerguson Gage & Valve Co.

*From advertisement, this issue

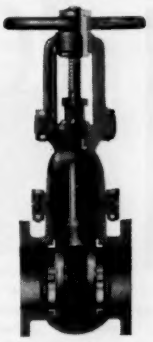
HANDLING "PROBLEM" FLUIDS OR GASES?

Specify Aluminum Gate Valves by DARLING

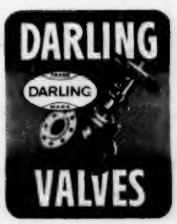
Where you're handling highly corrosive materials... or where valve weight is a factor... Darling Aluminum Gate Valves make sound economic sense.

High-corrosion-resistant aluminum alloys carefully selected and thoroughly tested by Darling metallurgical engineers, are used for structural and pressure-containing parts. They've been *proved-in-use* as the most generally corrosive-resistant aluminum alloys in use today.

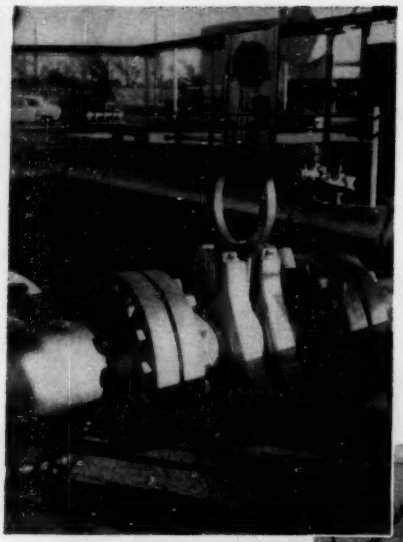
Double disc parallel seat principle assures maximum life under the most exacting service conditions. "No pocket" discs and wedges prevent accumulation of line scale or sludge. Wedge design reduces friction to a minimum, assures positive sealing and ease of operation.



Aluminum flanged end gate valve. Also available with other types of ends. Can be furnished with inside screw stationary stem.

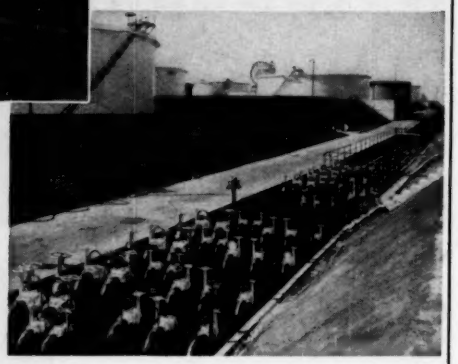


DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.



FAST, EASY, POSITIVE LINE BLINDING

Hamer Line Blind Valves



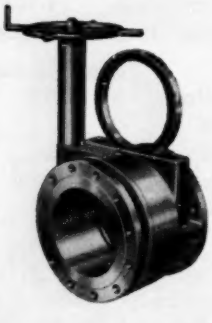
The famous 3-Bolt Hamer Line Blind Valve has set the standard for positive, dependable, economical line blinding in all industries.

FAST... because one man can reverse the spectacle plate from open to closed position in a matter of minutes.

EASY... because bar or handwheel operation provides tremendous leverage for spreading and tightening the hubs that hold the spectacle plate. Wedges, hammers, wrenches needed for spreading conventional flanges are eliminated.

POSITIVE... because nothing seals as securely and permanently as the solid spectacle plate clamped between the hubs of a Hamer Line Blind Valve.

Ask your nearest Hamer Line Blind Valve specialist about the multiple advantages of installing them wherever positive line shut-off is essential. Write for new Hamer Valve Catalog 60.



Handwheel operated Hamer Rigid Type Line Blind Valves are ideal for installation where conditions prevent spreading the line to reverse the spectacle plate.

WECO **WELL EQUIPMENT MFG. CORP.** HV-2-60
HOUSTON, TEXAS
Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

WECO UNIONS

CHIKSAN SWIVEL JOINTS

HAMER LINE BLIND VALVES

HAMER PLUG VALVES

LITERATURE . . .

Meters.....Instruments that measure and control flow, temperature, pressure, etc. in a wide variety of types for different operations. Booklets offered.
28-29 *Fischer & Porter Co.

Particle Counter.....is self-contained instrument said to be useful both for research work and for monitoring particulate matter. Information is offered.
37-38e *U. S. Industrial Chemicals

Potentiometer.....Modular construction, plug-in components make the new Electronik 17 the easiest of all potentiometers to operate, convert & maintain. Inform.
40-41 *Minneapolis-Honeywell

Power Flow System.....for the Univac solid-state system uses an iterative method for calculating the voltage & angle of each bus in the system.
238A *Remington Rand Corp.

Simulator.....New Unit Operations simulator for the 1620 data processing system is now available. Consists of 13 automatically available sub-routines.
179 *International Business Machines

Thermometers.....Bi-Metal thermometers make accurate temperature readings sharp and sure at all check points. Further information is found in Catalog 155.
70 *Manning, Maxwell & Moore

Pipes, Fittings & Valves

Ball Valves.....feature heavy duty stem and ball stop, solid Teflon packing, husky wall section and many other features. A 64 page ball valve catalog is offered.
216 *Pacific Valves, Inc.

Control Valves.....Model 1900 self-draining control valve has many applications in the process industries. Latest technical information is available.
117 *The Annin Company

Fittings.....are made to specifications which exceed the requirements of applicable A.S.T.M., A.S.A. & M.S.S. codes. Further information in Bulletin 416.
89 *Flowline Corp.

Gate Valves.....Monel seat bronze gate valves give full protection against all the stresses encountered in use. Further information about these valves in Folder 181-C.
61 *Jenkins Bros.

Globe & Angle Valves.....designed especially for chemical and industrial application. Wear & maintenance problems drastically reduced. Catalog No. L-475.
211 *Bastian-Blessing Co.

Heat Exchanger Tube.....Trufin type S/T tube is available in a wide range of alloys & sizes. Trufin type S/T Duplex is also available for use as an outer tube. Inform.
113-114 *Wolverine Tube, Div. of Calumet

Jacketed Pipe & Fittings.....Special jigs insure uniformiy of the jacketed area. Fittings & valves in cast or welded construction. Details in Bulletin J-57.
BL245 *Hetherington & Berner

*From advertisement, this issue

Pipe.....Bondstrand plastic pips is made of tension-wound glass filaments impregnated with resin. Complete information is available in bulletin on physical & design data.
191 *Amercoat Corp.

Pipe.....Aluminum process pipe is strong, lightweight and corrosion-resistant. Offers many advantages over ordinary pipe. A complete literature file is available.
215 *Reynolds Metals Co.

Pipe, Epoxy.....A complete size range that handles a temperature range from 65 to 300 F. Withstands an operating pressure range up to 1,200 psi. Information.
207 *Fibercast Co.

Pipe & Tubing Measurement.....Booklet supplies standard method of measurements and discusses both similarities and differences involved in measuring various fittings.
239A Aeroquip Corp.

Plastic Pipe.....10-page brochure contains table of properties, working pressure, flow chart, and other pertinent information on quality and performance of plastic pipe.
239B Johns-Manville Corp.

Production Parts.....manual prepared for the convenience of design engineers contains specifications on adapter couplings, bushings, elbows, tees, hose assemblies etc.
239c Lincoln Engineering Co.

Tubing.....Penflex tubing has been proved in many applications. Proper selection and application of flexible tubing is assured. "Flexineering" data book & cat. is offered.
L226 *Penna. Flexible Met. Tubing Co.

Tubing, Pressure.....Seamless tubing is available in all common carbon, alloy & stainless grades, up to 11" O.D. and with wall thickness up to 3¼".
123 *Timken Roller Bearing Co.

Tubing Testing.....Article contains short description of how various nondestructive tests of small tubing are applied and describes their advantages and disadvantages.
239D Superior Tube Co.

Valve.....New Sampling Valve cannot clog. Designed for simple installation in existing systems, merely by welding a ¾" half coupling into the pipe or vessel.
BR258 *Strahman Valves, Inc.

Valve, Pressure Sealing Gate.....for pressures to 720 psi. and temperatures to 250 F. Sizes 2" through 30". Additional information in Catalog 1200.
163 *W-K-M Div. of ACF Industries

Valves.....shut tight on any service, open easily every time, no lubrication necessary. They are available in a wide range of materials. Information available.
36 *DeZurik Corp.

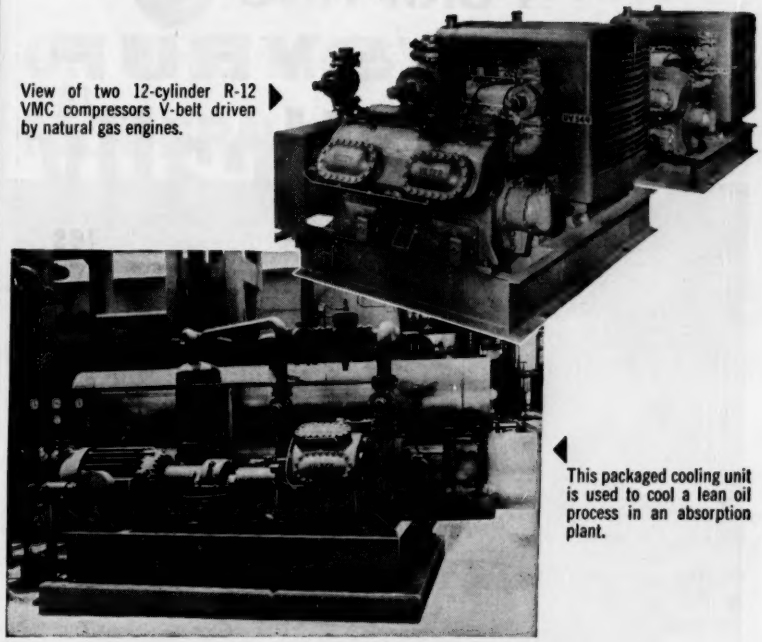
Valves.....Type G Sleeveline valves are available in ductile iron or stainless steel, screwed or flanged ends, from ½ through 6", with 150 psi rating. Bul. V/12.
189 *The Duriron Co., Inc.

Valves.....Forged steel valves are available on all lines up to 2 in. Designed to meet control requirements with minimum replacement & maintenance. Information.
213 *Ohio Injector Co.

*From advertisement, this issue

"Spot" Vilter Package Refrigeration Units where you need them

View of two 12-cylinder R-12 VMC compressors V-belt driven by natural gas engines.



This packaged cooling unit is used to cool a lean oil process in an absorption plant.

Both *packaged cooling units* and *packaged compressor units* for use with remote heat exchangers are available from Vilter for installation at the actual site in your process where cooling is required. Custom designed to fit your load at your conditions for maximum performance, these rugged, heavy-duty, long-life Vilter units simplify handling, erection and relocation.

Typical of the equipment Vilter supplies are the units shown above. The packaged compressor units are 12-cylinder, R-12 VMC compressors, V-belt driven by natural gas engines. The packaged cooling unit is used to cool a lean oil process in an absorption plant and incorporates an 8-cylinder, R-22 VMC compressor, a 20" x 14' long chiller and a 16" x 12' long condenser.

Vilter has successfully resolved many problems of cooling under intense pressures, and has designed and produced hundreds of heat exchangers, pressure vessels, and high pressure synthesis condensers to exacting specification for many types of chemical and petroleum applications. Vilter facilities include automatic welding, X-ray and Zyglo-Pentrex inspection.

Vilter's experienced personnel, its broad, custom-design background and its special "packaged" compressor and cooling units—explosion proof if necessary—can be of real help.

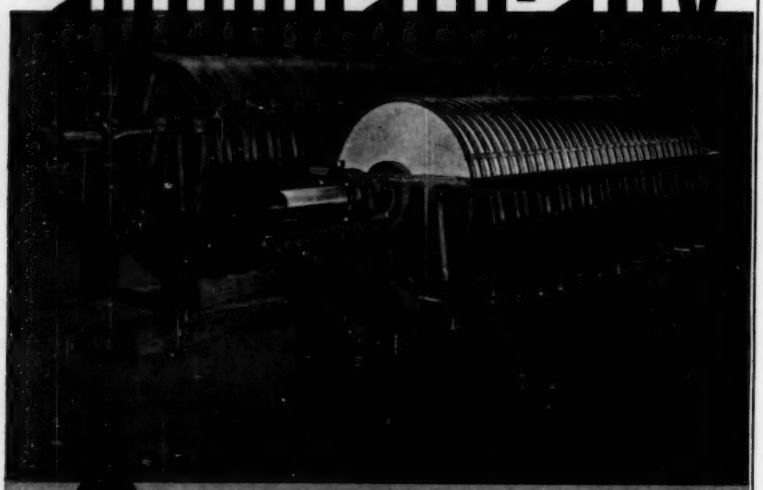
Many leading names in the chemical, petrochemical and petroleum industries look to Vilter for their special refrigeration, heat exchanger and vessel needs. Why not consult with Vilter about your problem?

Vilter® refrigeration air conditioning

The Vilter Manufacturing Company
Milwaukee 7, Wisconsin
Air Units • Ammonia and Freon Compressors • Booster Compressors Baudelot Coolers • Water and Brine Coolers • Blast Freezers Evaporative and Shell and Tube Condensers • Pipe Coils Valves and Fittings • Pakice and Polarflake Ice machines.

Write for helpful bulletins (820, 427) to The Vilter Manufacturing Company, Dept. K-607 2217 South First Street Milwaukee 7, Wisconsin

DECOLORIZING,
PURIFYING
CORN SYRUP
automatically



VALLEZ ROTATING LEAF
PRESSURE FILTER

These Vallez rotating leaf pressure filters were designed specifically for removing color and purifying corn syrup. The complete filter element is all stainless steel type 316 construction, with special nylon filter cloth. The filters can be completely controlled by automation.

Write for complete detailed information on this and other G-B process equipment.

See our catalog in Chemical Engineering Catalog.

GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
P. O. BOX 631 BIRMINGHAM, ALABAMA
FILTERS • EVAPORATORS • PROCESS EQUIPMENT • CONTRACT MANUFACTURING including HEAVY CASTINGS

LITERATURE . . .

Valves.....Forged steel ASA class valves for 400 deg. F. maximum working temperatures plus ASA class valves for 450 deg. F. maximum. Prices available.
177 *Orbit Valve Company

Valves.....2-way, 3-way and 4-way with full port openings. Screwed connections and adapters with Van Stone flanges for flanged piping. Bulletins and prices offered.
BR226 *Ronningen-Petter Co.

Valves, Ball.....A new catalog contains 32 pages of data on the newest, finest valves for corrosive & non-corrosive services and is available on request.
79 *Hills-McCanna Co.

Valves, Control.....A copy of an informal booklet called "25 Ways To Be Right" . . . in selecting control valve is now available on request.
10-11 *Minneapolis-Honeywell

Valve, Gate.....Aluminum gate valves feature high corrosion-resistance and double disc parallel seat principle. Wedge design reduces friction.
237 *Darling Valve & Mfg. Co.

Valves, Line Blind.....Hamer line blind valves offer fast, easy positive line blinding. The new Hamer Valve Catalog 60 is available.
238 *Well Equip. Mfg. Corp.

Process Equipment

Air Separators.....offer precise separation and improve screening. Increase 40 to 400 mesh output as much as 300%. For further information Bul. 087 is offered.
R210 *Sturtevant Mill Co.

Blender.....Liquid-solids blender granulates tablet formulations in a single step. A new report on solid-blending and Catalog 16-P on process equipment is available.
76-77 *Patterson-Kelly

Centrifugal..... The Batch-O-Matic handles greater out-of-balance loads with minimum vibration because of its low, compact design & exclusive center-slung suspension. Bul.
220 *American Machine & Metals, Inc.

Centrifugal.....Bulletin 1288, "Super Conejector: Setting The Pace For Efficient, High Production Processing" gives the full story of this new concept.
57 *Sharples Corp.

Classifying Systems.....Operate to critical size specification at well over 90% efficiency. Used in iron ore beneficiation, removal of particles, etc. Literature.
52 *The Buell Engineering Co.

Continuous Dewatering Presses..... Catalog "A" contains complete information that can help you with your Pressing, Drying and Cooling problems.
B248 *Davenport Machine & Foundry

Continuous Dryers.....Kathabar Humidity Conditioning Units; Air heaters instead of individual burners; Laboratory Facilities for testing products. Facts available.
241 *Surface Combustion

* From advertisement, this issue

Dispersion Mixers.....offers many special features for processing solid propellants. Available in a complete range of laboratory & production sizes. Bul. 1157.
109a *The J. H. Day Co.

Dryer.....Louisville fluidized bed dryer is almost entirely maintenance-free and accommodates a wide variation of throughput. Details in Bulletin FBD-61.
87 *Gen. American Transp. Corp.

Dryer.....SCL dryer is new in compactness, appearance, performance and economy. Has lower housing and complete accessibility of all parts. Bulletin 462.
173 *Proctor & Schwartz, Inc.

Dryers.....Oriad Desiccant dryers offer complete reactivation, perfect temperature control, and full automatic operation. Further details in Bulletin D-103.
183 *The C. M. Kemp Mfg. Co.

Evaporators.....An eight page treatise, Forced Circulation Evaporators, on salting and non-salting types, single & multiple effects is offered. Bul. SW205.
181 *Swenson Evaporator Co.

Fabric Filter.....An extremely varied group of filter sizes, shapes & types is available. Specific information is offered along with an air pollution analysis kit.
196 *John Wood Company

Filter.....This vacuum filter offers high throughput of solids per ft. of filter area, sharp separation of wash liquors from the filtrate and from each other.
2 *Bird Machine Co.

Filters.....Details on how custom engineered Niagara Filters can help with your processing problems is contained in Bulletin NC-457 which is now available.
221 *American Machine & Metals, Inc.

Filters.....All filters are characterized by high filtrate-clarity, rapid cleaning, high flow rates, and low filter cycles. Technical bulletins on request.
L258 *Hercules Filter Corp.

Filters, Leaf.....The vertical leaf filter is available in vertical & horizontal tank types, in a wide range of leaf & tank sizes. New Bulletin 150 tells the story.
236 *T. Shriver & Company, Inc.

Filtration.....Standard line of filtration equipment includes over 4311 different models and media. For complete information a catalog is available.
32 *Commercial Filters Corp.

Gas Absorbers.....Consist of three basic components: wetted impingement-type cells, wetted fiber cells and dry fiber cells. For details see Bulletin AP-125.
34-35e *Buffalo Forge Co.

Laboratory Homogenizer.....Minimum sample one pint; capacity 15 GPH; pressures up to 8000 PSI. Additional information is contained in Bulletin LH-55.
R194a *Manton Gaulin Mfg. Co., Inc.

Mill.....The two-stage design of the RE Colloid Mill provides continuous micrometer control for producing superior emulsions or dispersions. Bul. C-57.
R194b *Manton Gaulin Mfg. Co., Inc.

*From advertisement, this issue

WHERE CAN A COMPANY OBTAIN INFORMATION ON THE MOST MODERN METHODS OF CONTINUOUS DRYING?

One company recently placed orders for nearly $3,000,000 worth of Surface continuous dryers. More and more chemical and food plants are using the modern services of Surface Combustion engineers.

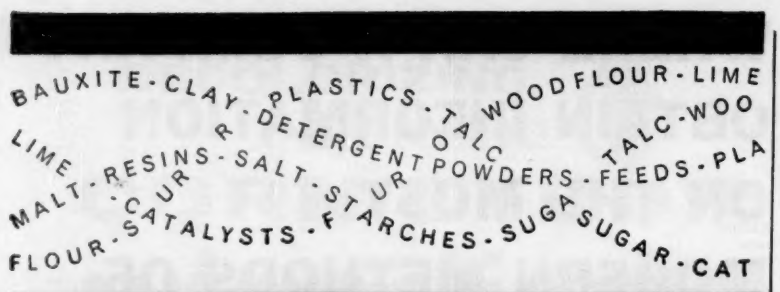
Purchasers are demanding dryers custom designed to fit the particular problem rather than "Hand-me-downs" to complete the plant automation.

Surface Combustion engineers have many advantages to offer: Kathabar Humidity Conditioning Units; Air heaters instead of individual burners; Laboratory Facilities for testing customers' products; large organization of engineers experienced in mechanical and structural design.

GET FACTS

SURFACE COMBUSTION
A division of Midland Ross Corporation
2380 Dorr Street, Toledo 1, Ohio
Send facts on Kathabar systems for following application:
.....
name & title .....
company .....
street .....
city .....*zone*.....*state*.....
59-4

In Europe: NEDAIRCO, The Hague. In Japan: CHUGAIRO, Osaka.


BAUXITE · CLAY · PLASTICS · TALC · WOODFLOUR · LIME
LIME · RESINS · SALT · STARCH · DETERGENT POWDERS · FEEDS · PLA
MALT · CATALYSTS · FLOUR · SUGAR · CAT

if it can be air conveyed

FLO-TRONICS®

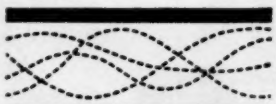
fluidization can do it

... more economically and efficiently! Since their introduction, more and more firms using powdered or granular materials are realizing tremendous savings with Flo-Tronics Fluidization air conveyance systems. They eliminate the cost of individual containers, vastly reduce costs of hand labor, free space and working capital, and provide complete sanitation.

Typical savings (on an investment of $24,000) realized by a paper mill handling bulk starch are illustrated in this table.

Volume (one type of starch)	*2,000,000 lbs.*	*3,000,000 lbs.*
Annual Savings		
(a) Bulk Price Differential—$.27/cwt	*$5,400*	*$8,100*
(b) Unloading, handling & losses—$.15/cwt	*3,000*	*4,500*
TOTAL SAVINGS	*$8,400*	*$12,600*
Annual Costs		
(a) Depreciation (over 15 years)	*$1,600*	*$1,600*
(b) Taxes (1% of investment)	*240*	*240*
(c) Repairs & maintenance (4%)	*960*	*960*
(d) Operation (labor, power, etc.)	*380*	*550*
TOTAL COSTS	*$3,180*	*$3,350*
Summary		
Annual savings before Federal Inc. Taxes	*$5,220*	*$9,250*
Return before Federal Inc. Taxes	*21.8%*	*38.5%*
Net savings after Fed. Inc. Taxes (at 52%)	*$2,505*	*$4,440*
Return after Federal Inc. Taxes	*10.4%*	*18.5%*
Pay out time (after deprec. & Fed. Taxes)	*9.6 yrs.*	*5.4 yrs.*

Whether you require a complete Fluidization system or merely system components, Flo-Tronics can custom-build to your specifications or requirements. For an engineering evaluation of your material handling requirements—or simply a discussion of your needs with your own engineers, write or call Mr. William P. Edmunds, Dept. 103.



FLO-TRONICS INC

1420 zarthan avenue

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LITERATURE . . .

Mills.....3-roll mills produce fine dispersions of fuel curing agents. Built in 10"x22" & 14"x30" sizes for productions & 5"x12" & 4"x8" for pilot operations. Bul. 158.
109d *J. H. Day Co.

Mixers.....Mix-Muller saves valuable raw materials and in many cases eliminates secondary processing. Details on a laboratory conducted survey & Handbook on Mulling.
137 *National Engineering Co.

Mixers.....A full line of side drive, tank top, portable or tripod and continuous pipeline mixers for your mixing needs. Additional information in Bulletin 582.
129 *Nettco Corporation

Mixers, Pony.....A model for every need with single motion or twin motion mixing action, 1 or 2 speed motors, in working capacities from 3 to 125 gal. Bul. 500.
109b *The J. H. Day Co.

Molecular Vacuum Stills.....Operating costs of high vacuum stills are less than 1/10¢ per pound because of lowered heat input, higher yield. Bulletin 3-1.
244 *Consolidated Vacuum Corp.

Pressure Filter.....Vallez rotating leaf pressure filters were designed specifically for removing color & purifying corn syrup. Information on this & other equipment.
240 *Goslin-Birmingham Mfg. Co.

Process Equipment.....Catalog 392 covers research, engineering and service of evaporation, drying, solvent recovery, cooling and other processes.
16-17 *Blaw-Knox

Process Equipment.....8-page bulletin contains photographs and specifications of forty-four different items of equipment for the mineral and chemical processing industries.
242A Denver Equipment Co.

Process Equipment.....Mixing, cooking or cooling equipment plus vacuum pans, coils, coating pans, filters, tubular heat exchangers, etc. are covered in Engineering Manual.
L260 *Groen Mfg. Co.

Process Equipment.....Rubber-lined processing equipment to meet the most specific corrosion or abrasion-resistant services. Rubber Division bulletin offered.
120 *Industrial Filter & Pump Mfg.

Process Equipment.....Technical information on Homogenizers, Sub-Micron Dispenser, Triplex Pumps, etc. is contained in bulletins that are available.
195 *Manton Gaulin

Process Equipment.....such as dryers, coolers, combination ammoniator-granulators, furnaces, cookers, reactors, presses and pilot plants. Literature is offered.
231 *Edw. Renneburg & Sons

Processing Equipment.....A 32-page report on impervious graphite processing equipment covers 16 different types of equipment. Includes sizes, dimensions & costs.
127 *Falls Industries, Inc.

Pulp Refiner.....Bulletin 231 contains complete construction details and dimensional information on a 42" double disc refiner that provides a free flow of stock.
242B Sprout, Waldron & Co., Inc.

* From advertisement, this issue.

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Put the squeeze on the residue from your commercial separation process—and chances are you'll recover extra profits in the form of saleable byproducts.

Many industries are doing it right now with CVC Molecular Vacuum Stills—at a utility cost of *less than 1/10¢ a pound!* And CVC Stills handle today's widest range of organic and silicone products (from 250 to 4000 molecular weight).

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LITERATURE . . .

Purifiers.....Hi-eF Purifiers have patented two-stage principle of separation with no moving parts. Special Manual 803 contains data on 13 types of separators.
BL243 *The V. D. Anderson Company

Ribbon Blenders.....in a variety of materials . . . with powerful drives . . . and various types of agitators . . . in capacities that range from 7½ to 3850 gal. Bul. No. 800.
109c *The J. H. Day Co.

Screens.....Ro-Ball gyrating screens use super-active ball cleaning principle to sift foreign materials from oxidizers and additives. Bulletin 957.
109e *J. H. Day Co.

Scrubbing Towers..... Hydraulic scrubbing towers are highly efficient and need little maintenance. Available with corrosion resistant linings. Bulletin AP-525.
34-35d *Buffalo Forge Co.

Spray Nozzle.. ....A comprehensive spray nozzle catalog is available. Contains complete, accurate performance data for each of the hundreds of spray nozzles in the line.
224 *Spray Engineering Co.

Spray Nozzles.....Catalog 24 contains 48 pagss of reference data on thousands of spray nozzle designs and sizes. Choice of capacities, characteristics & materials.
T248 *Spraying Systems Co.

Tornado Mill.....offers versatility in speed, in size of particles it handles, & in the rate of production. The 360 degree screen provides full working area.
205 *F. J. Stokes Corp.

Pumps, Fans & Compressors

Acid Pumps.....in 1" to 8" discharge sizes with 10 to 3000 GPM capacities, heads to 200' and higher. Pumping parts are available in a variety of alloys and plastic.
261 *A. R. Wilfley & Sons

Canned Pumps.....2-page bulletin gives design features and model specifications of "canned pumps" for leakproof pumping of corrosive, toxic, and other problem fluids.
244A Chempump Div.

Centrifugal Pump.....Series 1510-B pumps offer such features as vertical split case, removable bearing frame assembly, etc. Selection data are available.
36A *Bell & Gossett Co.

Compressor, Piston.....Non-lubricated ringless piston compressor assures absolute contamination-free compression of dry or moist gases. Information, specifications.
TL245 *Sulzer Bros. Inc.

Compressors.....built for the rugged duty typical of chemical plants. Heavy casings & conservative rod loadings enable them to easily handle air & gases. Bul. 2561-11.
64 *Joy Mfg. Co.

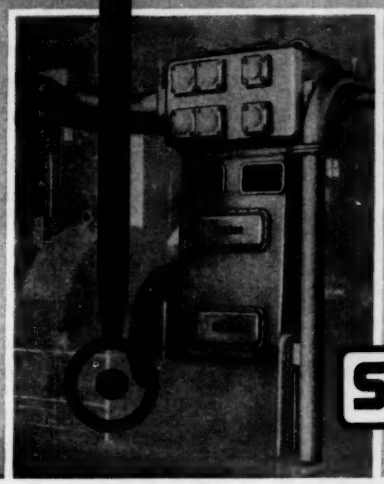
Fan.....New design duct fan by De Bothezat has a removable cone design. Descriptive literature on this new type is available on request.
222 *American Machine & Metals, Inc.

*From advertisement, this issue

NO LUBRICATION
NO CONTAMINATION
NO MAINTENANCE

SULZER
NON-LUBRICATED RINGLESS
PISTON COMPRESSOR

Assures Absolute
Contamination-Free Compression
Of Dry Or Moist Gases!



- Unique Ringless Piston And Frictionless Piston Rod Stuffing-Box Requires Little Or No Maintenance
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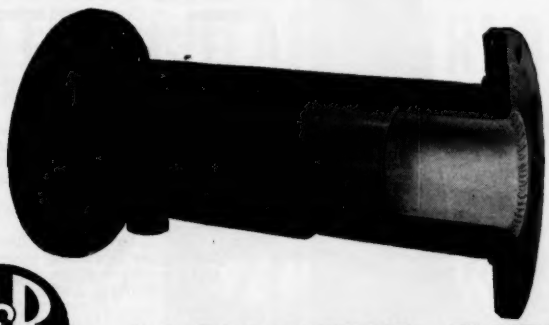

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and FITTINGS

H&B standard jacketed equipment gives complete jacketing of the product line. Special jigs enable H&B to insure uniformity of the jacket area. Fittings and valves are available in cast or welded construction in all alloys including stainless steel. All H&B jacketed equipment is hydrostatically tested to 450 p.s.i. H&B welded steel jacketed fittings are ideally suited for process piping with pressures reaching 300 p.s.i. and temperatures up to 750°F. . . . For more information send for bulletin J-57.

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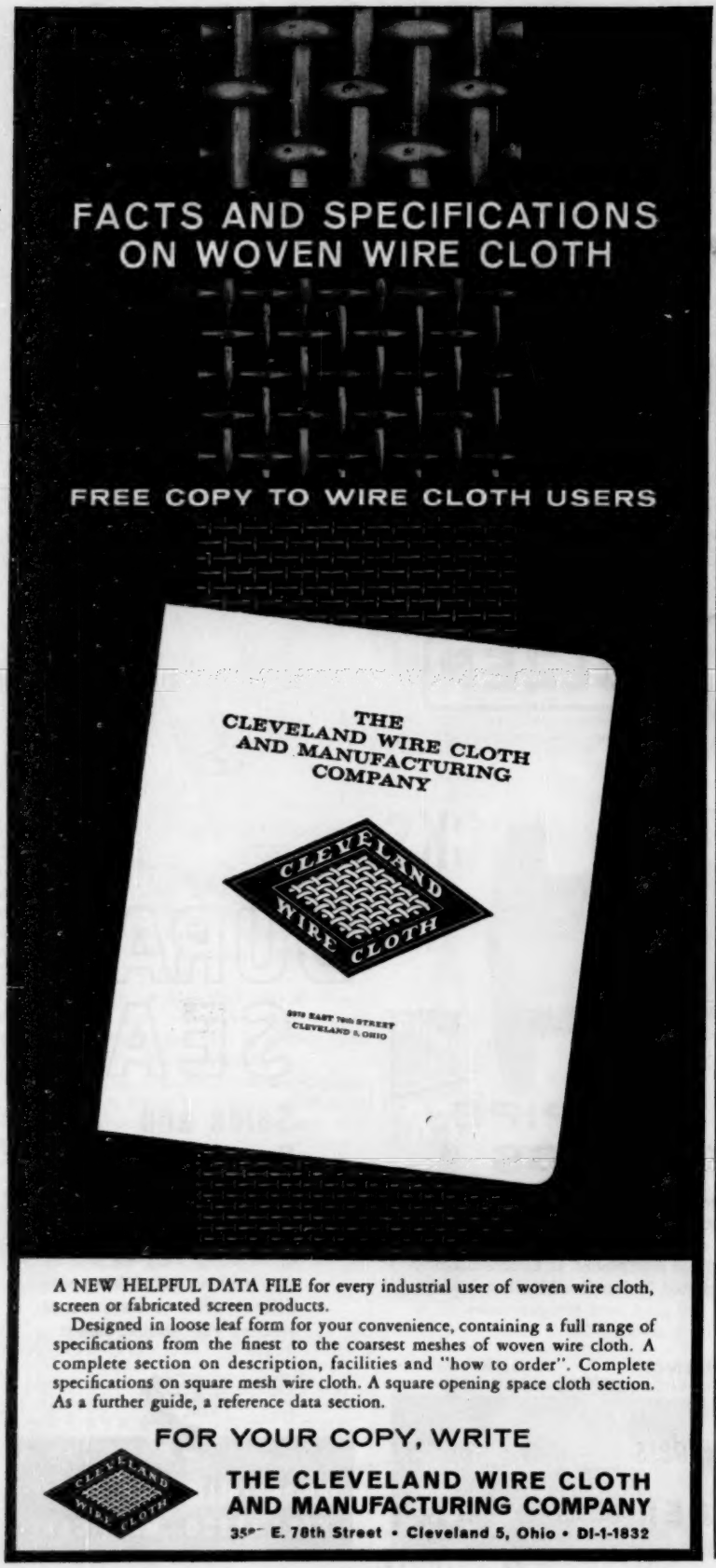

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LITERATURE . . .

Fan.....Resin-Bonded Fiber Glass Fume Fans are resistant to such chemical corrosives as acids, salts, gases, organic materials & others. Bulletin FI-511.
34-35a *Buffalo Forge Co.

Fan.....New Twinalator offers unique superior dual function air handling for all types of buildings. Further information is contained in Bulletin 552.
48 *Clarage Fan Co.

Fans, Rubber Lined.....have a rubber coating welded to all metal parts exposed to the air streams. Outlast ordinary fans 3 to 12 times. Bulletin 2324-F.
34-35b *Buffalo Forge Co.

Leakproof Pumps.....4-page bulletin describes the features of the new series G Chempump and includes complete performance curves and detailed cross-section of pumps.
246A Chempump Div.

Metering Pump.....Pulsafeeder metering pump offers precision metering at flow rates of from a few drops to 15.7 gal. per minute. Complete details in Catalog 59.
69 *Lapp Insulator Co.

Pump.....New positive displacement handles without turbulence, pulsation, aeration or agitation, corrosive-problem liquids of high or low viscosity. Catalog P 302.
208 *Waukesha Foundry Co.

Pump, Chemical Process.....Model 3195 pumps simplify process engineering and cut parts inventories. They offer maximum interchangeability. Bulletin is offered.
46-47 *Gould Pumps, Inc.

Pumps.....Complete information on capacities, pressures and sizes. Ability to solve pumping problems of the process industries. Reprint (Data Sheet 100) offered.
130 *Aldrich Pump Co.

Pumps.....Controlled capacity pumps for continuous, accurate metering of all types of liquids. Features exclusive liquid-end design. Information offered.
111 *Clark-Cooper Div.

Pumps.....to handle liquid oxygen and other liquefied gases. Vertical top suction construction to prevent gas binding. Details in Bulletin 203-8.
197 *Lawrence Pumps Inc.

Pumps.....made of new Delrin present a truly modern manufacturing approach in the pump field. Design provides for a variation in liners to meet different needs.
246B Planet Products Corp.

Pumps.....Single-stage, end suction pumps are available in full range of sizes to handle from 10 GPM to 2000 GPM. Corrosion-resistant metals protect all surfaces. Bul. 500.
234 *The Weinman Pump Mfg. Co.

Pumps, Centrifugal.....New catalog 130 describes 50 different models. Offer pressures: to 21 psi. in single stage pumps; to 70 psi. in multistage types.
54 *Eastern Industries Inc.

Pumps, Chemical Liquid.....Parts are standardized and interchangeable. Built of iron, stainless steel, monel, nickel, bronze, manganese steel & other materials. Bul. 982.
34-35c *Buffalo Forge Co.

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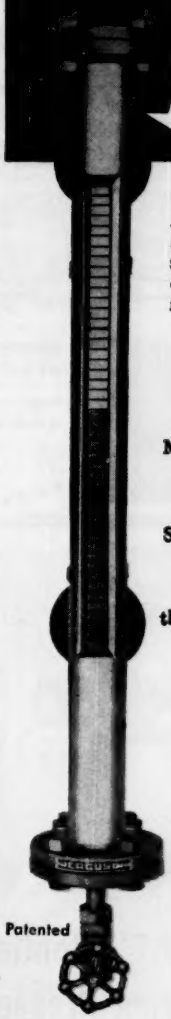
MAGNETIC GAGE

for liquid levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

Available with electric alarms.

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Can also be used for interface indication.

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Gages and Valves for the Observation of Liquids and Levels

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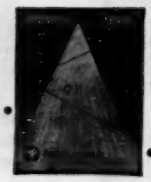
SPRAY NOZZLE
problem?

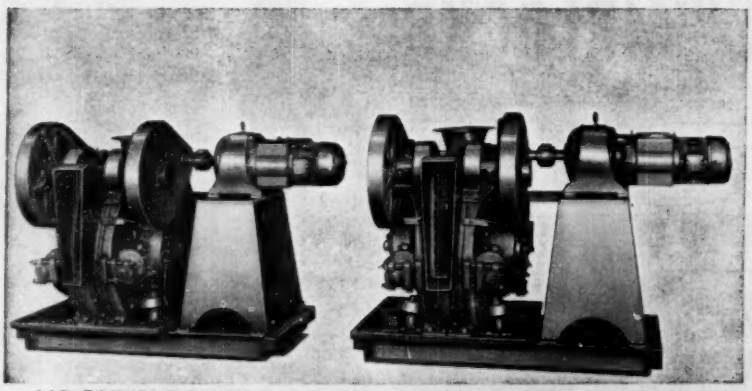
perhaps one of our **DATA SHEETS** *can suggest a solution*

For almost every spraying application, there's a Spraying Systems Data Sheet that gives useful information on suggested installations and types of nozzles to use. If you have a problem, write and let us know the application involved . . . and we'll send the Data Sheet that applies.



SPRAYING SYSTEMS CO.
3275 RANDOLPH STREET • BELLWOOD, ILLINOIS

And . . . for complete spray nozzle information, write for Catalog 24.



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Let our engineers consult with you on your Pressing, Drying and Cooling problems or send for our catalog "A". For quick reference consult your Chemical Engineering Catalog.

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PRESSING – DRYING and COOLING Equipment
Continuous DeWatering Presses
ROTARY DRYERS
Steam Tube, Hot Air and Direct Fire
Atmospheric DRUM DRYERS
ROTARY COOLERS
Water and Air

LITERATURE . . .

Services & Miscellaneous

Auto Fleet Leasing.....28-page study on the pros and cons of leasing auto fleets contains five complete tables and charts that analyse both fixed and variable costs.
248A Foundation for Management Research

Cleaning Service.....offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. Information offered.
93 *Dow Industrial Service

Drum Gauging Chart.....for determining how much liquid is left in an open drum is now available. It converts wet in. of stick measurement to liquid gals.
37-38b *U. S. Industrial Chemicals

Exchanger Cleaning.....Detailed literature on this cleaning process and other chemical plant maintenance operations is available now on request.
200 *Oakite Produts, Inc.

Fire Fighting Products.....Double strength foam is inexpensive & completely effective. Puts out fires fast, reduces storage costs & shipping costs. Information.
121 *Rockwood Sprinkler Co.

Fire Protection.....A 16mm. sound-color film demonstrating all types of fire hazards and how to guard against them may be borrowed.
44 *Grinnell Company

First Aid Kits.....for industrial institutional or professional use are described and illustrated in the new, 28-page catalog which is available on request.
37-38d *U. S. Industrial Chemicals

Floodlights.....Econoflood floodlights have an exclusive auxiliary inner floating reflector. Afford new economies in floodlighting. File 31-F-22 is available.
248B Appleton Electric Co.

Gratings & Assemblies.....Safety handbook and design manual features gratings for industrial purposes such as outdoor conveyor ramps, stair treads, floors, crossovers etc.
248C Bustin Steel Products Inc.

Knife Cutter.....engineered for tough size reduction jobs with superior results. Their application and versatility are practically unlimited. Bulletin 213.
206 *Sprout, Waldron & Co., Inc.

Sulfamic Acid Cleaners.....Booklet gives newly developed scale dissolution rates for sulfamic acid cleaners, plus diagram sheet showing simple equipment cleaning hookups.
248D E. I. du Pont de Nemours

Supervisory Techniques.....Booklet E-7, titled "Supervision- for Professional Advancement" is one of a series presented for engineers. A copy is available on request.
L256 *Western Supply Co.

Wood Products.....Bulletin 60 outlines & illustrates non-corrosive wood products, hardware and ideas for chemical processes and is available on request.
193c *Wendnagel & Co., Inc.

*From advertisement, this issue

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POSITION WANTED

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(Mechanical Engineer)
OVERSEAS

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To coordinate and expedite Refinery Mechanical operations manuals program.

Liberal salary, biennial home furlough, family housing available.

WRITE giving full details including education and resume of experience.

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SALARIES TO $14,000 PER YEAR
B.S. in Optics, Mechanical Engineering or Physics and with two or more years experience in optical engineering. To perform the optical engineering function on a broad line of products. Company client assumes all employment expense. Send resume in confidence.
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PHD'S $18,000 - $20,000
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Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rented equipment. Check this issue's listings—most complete in the field—for items you need now.

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▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date**—April 17 issue closes March 24. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

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Centrifugals: 12", 30", 40" & 48".
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Buffalo Vac. Drum Dryer, 24"x20".
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3—Devine & Stokes Vac. Shelf Dryers.
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Mikro Pulverizers #4, 2, 1, & Bantam.
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Spr. Waldron Stainless spike crusher.
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3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12' x 36" Steel.
Colloid Mills 1½ H.P. & up.
Mixers: BP & Day 75, 100 & 150 gal.
Baker Perk. 15 HP. Masticator Mixer.
Change Can Mixers 8, 15, 40, 150 gal.
Sprout-Wald. 10,000# horiz. Spiral Mixer.
Day Jumbo 700 gal. horiz. mixer.
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Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP. Centrifugal 250 PSI.
Sifters: Day, Robinson, Rotex type.
Tablet Machines: Stokes R, Colton 4½ T, single punch. Stokes RDI Rotary.
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187-8th St., Brooklyn 15, N. Y. Sterling 8-1944

CIRCLE A ON READER SERVICE CARD

LOCOMOTIVES—RR CARS & CRANES
9 Gen. Elec. 20, 25, 45, 65, 80, 100 & 125 Ton
25-Ton Industrial Brownhoist, 60' Boom Crane
200—50 Ton Box, 300—70 Ton Gondola Cars

PLANT EQUIPMENT
4' Traylor TY Gyratory Crusher
2—Wemco 2M-HMS Plants
36" x 96" H. R. Vibrating Pan Feeder. NEW
No. 1 Sturtevant Rotary Fine Reduction Crusher
F55 Syntron Grizzley Feeder
10—1½ & 2 Yd. V-Shape Dump Cars
2—5' x 3' KVS Air Sweet Ball Tube Mills
Ball Mills: No. 56, 5' x 5', 6' x 4' x 9' & 7' x 22'
Hardinge Mills: 3' x 8', 3' x 24" & 10' x 48", 5' x 22"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8" x 10", 10" x 20", 14" x 28", 18" x 36", 30" x 36", 48" x 60", 48" x 72", 66" x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½' & 7'
Crushers, Roll: 24" x 14", 30" x 14", 40" x 16"
Rotary Dryers: 3' x 30', 5' x 30', 6' x 50', 6' x 70' & 8' x 80'
Rotary Kilns: 36"x30', 6'x70', 7'x129' & 9'x160'
2—42" x 120" Buflovak Atmos. Double Drum Dryer
Roto Louvre #207-10 Type 316 SS, Link Belt
150—1½, 2 & 4 yd & 30 yd Dump Cars
Laboratory Rotary Kiln, 36" x 30". Complete
4' x 10' Tyler-Hummer Electric Vibrating Screen
2' x 6' & 3' x 12' Seco Single Deck Vibrating Screen
2—6' x 12' Allis Chalmers 2 Deck Vibrating Screens
16' Gayco Centrifugal Air Separator
BX-100 Sutton Steele & Steele Air Table NEW
6—36" x 32" Dings Magnetic Head Pulleys
650', 2200', 3068' & 3000'-IR Compressors
4160 CFM Sly Dust Collector
WANT BUY DRYERS—KILNS—CRUSHERS
R. C. Stanhope, Inc., 60 E. 42 St., N.Y. 17, N.Y.
Tel. MU 2-3075 or MU 2-1898

CIRCLE B ON READER SERVICE CARD

COMPRESSORS
No better values at any price

85 CFM (Actual) 3500 PSI Clark HO-6-4C
110 CFM 3000 PSI Ing. GC 50BW
138 CFM 100 PSI 7x7. Ing. ES, CP & Joy
288 CFM 100 PSI 9x9 Ing. Worth, CP
294 CFM 125 PSI 9x9 Joy WG-9
311 CFM 1500 PSI 10½-7¼-3½-13 IR-ES3
351 CFM 350 PSI 11-5x11 CP TCB-2
465 CFM 100 PSI 12x11-IR-ES CP.T, Worth HB
502 CFM 125 PSI 12x13 Worth HB
593 CFM 110 PSI 13½-8½ x 8 Worth, DC 2
686 CFM 100 PSI 14x13 Ing. ES
1050 CFM 60 PSI 13-13x12 IR-XRE
1290 CFM 125 PSI 13/8x7 Joy WN114-E
2200 CFM 100 PSI 26-15x18 Ch. Pn. ace 350 HP 3-6-4600 .8 PF
2520 CFM 125 PSI 17-10¾x8 Clark CMA-4L
3330 CFM 45-215 PSI Clark—CMA-6

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N.J. UNion 5-1397

CIRCLE C ON READER SERVICE CARD

SPECIALS

Kettles: Just received 69 Lee 40 gal. stain. clad, 40# WP.
Column: 24" x 22', 316 stain. steel.
Disintegrators: Rietz RD-18-P and RD-12.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
Dryer: Porter 2 x 4' vac. drum., st. st.
Centrifugal: Tolhurst 26" rubber, 2-speed.
Filter: Sweetland #5 st. st. lined.
Filter: Eimco, drum 16" x 12".
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Procter & Schwartz 6-tray st. st.
Centrifugal: AT & M 60" st. st. perf.

Write us or call Seeley 8-1431
Send us a list of your idle machines

LOEB EQUIPMENT SUPPLY CO.
820 W. Superior St., Chicago 22, Ill.

CIRCLE D ON READER SERVICE CARD

OVER 5,000 MACHINES IN STOCK
FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

CIRCLE E ON READER SERVICE CARD

EXCLUSIVE RIGHTS OFFERED TO MANUFACTURERS OF SPRAY DRYERS

Unique new conception Parallel Spray Dryer, only 32 ft. high, 1000 lbs. water evap/hr. 100% unbroken heads recovered. Instant-soluble products, foods, vegetable chemicals, soaps. By designer original patented Concurrent Dryer. Best ref. Any solids-containing liquids.

Write Secheurs Atomiseurs Co., 11 Ave., Grande Bretagne, Monte Carlo, Monaco.

CIRCLE F ON READER SERVICE CARD

MARCH SPECIALS

Abbe 5'x8' Jktd. Ball Mill, chrome mang. steel
2 Oliver Rotary Vac. Filters, 3'x2', 63"x8'
Day 200 gal. sigma arm jktd. Mixer, 7½ hp mtr.
Gruendler "BB" Hammermill, whirlbeater, 22"
Pfaudler 1500 gal. glass enclosed top Tank
Blaw Knox SS 100 gal. Autoclave, 1000 PSI
Simpson 18" Lab. Mix Muller, ¾ HP motor
Patterson-Kelly Twin Blender SS 5 cu. ft. 3 HP.
Ribbon Blenders, Steel & SS, all sizes, New & Used

WHAT HAVE YOU FOR SALE OR TRADE?
YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, INC.
111 33 STREET BROOKLYN 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE K ON READER SERVICE CARD

PERIODIC CHART—POCKET SIZE

- Plastic laminated for durability.
- Contains all chemical elements, their atomic weight, atomic no., density, etc. **Send $1.00**

R&S LAMINATING CO.
BOX 111—WHITE PLAINS, N. Y.

CIRCLE G ON READER SERVICE CARD

OUTSTANDING VALUES!

SS jktd & agit Reactors 400, 125, 50 gal.
Pfaudler 30 gal. gl. lined jack. and agit. reactor.
Readco 50 gal. dble. arm jktd. mixer.
40" rubber lined suspended centrifuge.

CHEMICAL & PROCESS MACHINERY CORP.
50-52 9th St., Brooklyn 15, N. Y. HY-9-7200

CIRCLE H ON READER SERVICE CARD

WIRE US COLLECT!

STAINLESS ROTARY DRYER

Hersey 4'x25' Rotary Stainless Steel Dryer type 316 SS. Complete with 12' long Furnace. 2-McKee Burners and Rotoclone SS Dust Collector.

Complete—Set to Operate

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE J ON READER SERVICE CARD

SPACE IS VALUABLE

Too often you see idle machinery occupying valuable floor space. Advertising space in the Searchlight Section is available to help you sell equipment you do not need.

Write Today To:

Classified Advertising
Chemical Engineering
P.O. Box 12, New York City 36, N. Y.

BRILL FOR VALUES

CENTRIFUGES

2—Sharples C-20 and C-27 Super-D Hydrator, 316 S.S.
1—Bird 18" x 28", Solid Bowl, Continuous, 304 S.S.
2—Bird 24" x 38" Solid Bowl Continuous 304 S.S.
1—Bird 32" x 50", Solid Bowl, Continuous, 316 S.S.
1—Bird 36" x 50", Solid Bowl, Continuous, 347 S.S.
1—Bird 40" x 60" Solid Bowl Continuous, 316 S.S., unused.
3—Sharples PY14, PN14 Super-D-Canters 316 S.S.
2—Fletcher 48" Suspended 316 S.S. Perforated Basket.
2—Sharples #16, 304 S.S., 3 HP motor.

REACTORS—EVAPS—CONDS—TANKS

1—150 gal. 304 S.S. jacketed agitated Reactor.
3—Pfaudler 200 gal. glass lined jacketed Kettles.
1—300 gal. Hastelloy B jacketed Kettle.
1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
1—550 sq. ft. Buflovak monel single effect Evaporator.
1—500 gal. S.S. Mixing Tank with nickel coils.
6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
2—1000 gal. 304 S.S. Tanks, 5'6" x 6'.
1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
1—2,000 gal. horiz. 304 S.S. tank, 5' x 12'.
1—2500 gal. vertical 304 S.S. Tank, 8'x 7'.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
6—Stainless Heat Exchangers; 1220, 786, 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Column.

FILTERS

1—#5 Sweetland Filter 304 S.S. 120 sq.ft.
1—Oliver 6' dia. Horizontal Filter, 316 S.S.
1—Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
1—Oliver 5'3" x 8" Steel Rotary Vacuum, vaporitite housing.
1—Feinc 3' x 3' Stainless Steel Rotary Vacuum Filter.
2—#12 Sweetland Filters, 36 leaves, 4" centers, 500 sq. ft.
1—Feinc 5' x 6' Stainless Steel Rotary Vacuum Filter.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

DRYERS

1—Buflovak Vacuum Shelf with 20—60" x 80" shelves.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Buflovak 32" x 90" Atmos. Twin Drum Dryer.
2—Devine 4' x 9' single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
6—Louisville Rotary Steam Tube 5' x 25', 6' x 30', 6' x 50'.
2—Louisville 8' x 50' Stainless Steel lined Rotary Dryers.
9—Rotary Dryers 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
2—Link Belt, 7'5" x 25', 6'4" x 24", S.S. Louvre Dryers.
1—Stokes model 38-A Tray Dryer with 16—36" x 36" S.S. Shelves.
2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
1—P&S 6' wide Apron Conveyor Dryer 48' long.
2—10' and 4' dia. 304 S.S. Spray Dryers.

MIXERS

1—Abbe 110 gal. 304 SS Jacketed Agitated Vacuum Dispersall Mixer.
2—Day Imperial 150 gal. jktd. double arm.
1—Baker Perkins 100 gal. jacketed double, arm, 30 HP.
1—Baker Perkins 50 gal. jacketed, double-arm.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—Patterson 6' dia. Conical Blender 15 HP.
1—3' dia. Simpson Intensive Mixer.
1—2' dia. Simpson Intensive Mixer 304 SS.
1—45" dia. Lancaster Mixer 7½ HP motor.
1—Patterson Kelly 150 cu. ft. Twin Shell Blender.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 750 cfm, 1 micron, 15 HP.
2—Hardinge 5' x 22" steel lined conical Ball Mills.
4—Mikro Pulverizers 4TH, 1 SH, 1 SI and Bantam.
3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.
1—Raymond 10" vert. Mill, 10 HP.
1—No. 1 Ball & Jewell Rotary Cutter.
1—#18 Cumberland Rotary Cutter.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
2—#842 Rotex Sifters 60" x 84" double deck.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
3—Nash H6 Vacuum Pumps.
4—Stokes Rotary Tablet Machines DD2-DDS2-DS3-RB2.

Partial List of Values—Send for Complete Circular

BRILL EQUIPMENT COMPANY

35-61 JABEZ ST., NEWARK 5, N. J. Tel: MArket 3-7420—N. Y. Tel. RE 2-0820
TEXAS OFFICE: 4101 San Jacinto St., Houston 4, Texas—Tel: JAckson 6-1351

CIRCLE L ON READER SERVICE CARD

FILTER PRESSES—6" lead P&F w/pump, 18x18 (26 chamber), 30x30 (11 chamber)

MILLS—Hardinge Conical, 3'x8", 3'x24", 5'x22", 8'x36", 8'x48", 6'x12' rod w/200 HP

VACUUM PUMPS—115 CFM Beach Russ RP w/5 HP motors, Leiman 105 CFM, Dorr Oliver 200 CFM-piston

DRYERS—ROTARY—24"x22', 3'x24', 4'x40' 5'x50', 7'x58', all w/motor drives.

MIXERS—New 3 qt. sigma/jacketed, 5 gal. Bramley 5 HP vac./jack., 12 gal. sigma, 22 cu. ft. ribbon blender.

E. W. LAWLER has stopped piloting International Jet Liners—Full time super service now for YOU.

MIKRO BANTAM w/vari feed drive, 4TH Mikro (unused) w/Mikro collector & 3x5 Tyler screens for closed circuit.

LAWLER COMPANY

Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE M ON READER SERVICE CARD

PEP UP YOUR PROFITS!

GET THE MACHINE YOU NEED NOW!

2—3500 gallon Horiz Rubber Lined Storage Tanks. 10 PSI int. press

1—Raymond 6' dia Stainless Steel Double Whizzer Air Separator

3—Polybloc Impervious Graphite Heat Exchangers Model 13-2. Each with 13.6 sq ft area.

1—Mojonnier SS Triple Effect Lo Temp Evaporator. 7000# water evap. per hr. 500 HP Refrigeration unit

4—Karbate Model 4CA9½ Cent Pumps. 6" inlet, 4" outlets. 40 HP 1800 RPM, direct connected. New 1958

1—Tyler 4'x12' Ty-Rock Single Deck Screen type F-800

2—Claridge Rubber covered Blowers type IE size 29.50 HP TEFC Mtr. 10,000 to 15,000 CFM @ 10" to 18" Static pressure.

40—Stokes Model 212 C Microvac Hi Vacuum Pumps. 115 CFM 5 HP

MACHINERY AND EQUIPMENT COMPANY

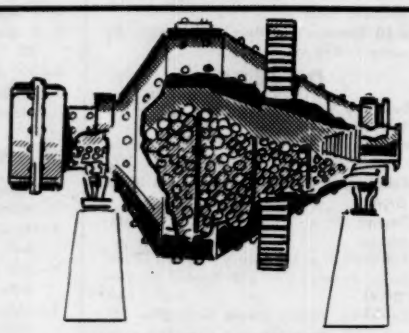
123 Townsend St. · San Francisco 7, California

CIRCLE N ON READER SERVICE CARD

Renting Equipment has many advantages!

SPOTLIGHT SPECIALS

3 Buflovak Thermo Recompression Stainless Sanitary Evaporators.
J. H. Day 125 Gal. Gearless Pony Mixer.
Raymond Hi-Side Mill 5057; 60 HP.
Royle No. 1 Jacketed Extruder.
Stokes #250 Molding Press; 150 Ton.
Oliver Dorrco Rotary Vac. Filter 6'x3' with NICKEL contacts.
Colton Stainless Oscillating Granulator.
International 8'x8' Porcelain Lined Pebble Mill with 50 HP Gear-Motor.



FIRST'S WEEKLY FEATURE
SAVE $3500
On THIS Hardinge Conical Ball Mill 3' x 8" with Feeder, Cyclone Collector, Fan, Motors, etc.
FIRST COME—FIRST SERVED

REACTORS—PRESSURE VESSELS

2 Stainless 400 gal. Reactors Jktd. Agtd. by Patterson and Struthers Wells.
6 Dorr-Oliver Stainless Steel Thickeners or Reaction Vessels; 550 gal. 5' x 5'.
Stainless Reactor, 2000 gal. Fully Jktd.
Lancaster Stainless Lined Rotary Reactor or Digester; 50" x 17'4"; Jacketed; good for 300 PSI Internal.

CONTINUOUS FINE GRINDING EQUIPMENT

To be Sold Direct from Location

2 Allis Chalmers 7'x22' (2 Compartment) Compeb Mills, Meehanite Liners; 400 HP
1 Allis Chalmers 9½ x 810 Preliminator or Continuous Ball Mill; Meehanite Liner magnetic-coupled to 400 HP Motor
3 Allis Chalmers 7'x22' Continuous Ball Tube Mills, Meehanite Liners, each driven by a magnetic coupled 400 H.P. Motor now operating in closed circuit with
3 Raymond 14 Ft. Double Whizzer Mechanical Air Separators, each driven by 75 HP Motor. New in 1950

MIXERS ALL TYPES

Baker Perkins Jktd. 5 gal. UNE-7, Dbl. Arm Mixer with pressure cover.
Readco Jktd. 15 gal. Dbl. Arm Sigma Blde Mixer.
BLAW-KNOX 600 cu. ft. Conical Blender.
Stainless Steel 150 gal. Jktd. Dbl. Arm Mixer with Vac. Cover; Hydr. Tilt.
Other Baker Perkins Jktd. Mixers, 150 gal., 200 and 300 gal.
J. H. Day Cincinnatus Dbl. Arm Mixer; 300 gal. STAINLESS Jacketed.

CENTRIFUGES

Stainless Centrifugals from 30" to 60"; A.T.&M. Tolhurst, Fletcher, etc.
Tolhurst 40" Suspended Centrifuges; Rubber Covered Perf. Baskets and Curbs; Monel Plow-Discharge.
2 Sharples Stainless Steel Model PN14 Super-D-Canters.
4311 S 1 Sharples C 27 Super-D-Hydrator in Type 316 Stainless with 40 HP.
5147 S 13-14 Two Bird Continuous Screen Type Horizontal Centrifuges; Monel & S.S.; 24" x 24".

FIRST MACHINERY CORP.

209-289 TENTH STREET, BROOKLYN 15, N. Y.

FMC Pays MORE For Your Surplus

PARKING ON THE PREMISES
Phone: STerling 8-4672
Cable Address: "EFFEMCY"

CIRCLE O ON READER SERVICE CARD

LIQUIDATION
OMAHA, NEBRASKA

MAJOR ITEMS

1—2350 gal. Stainless tank, coils.
3—1000 KVA trans., 13800—460 v.
5—Buflovak 42" x 120" dbl. drum dryers, ASME 160#
2—American 36" x 84" double drum dryers
2—Bonnet 7' x 60' rotary dryers
1—Bonnet 6' x 52' rotary dryer
9—Davenport #1A #2A dewatering presses, vari-drives
2—French Oil type 2-S screw-type extraction presses 300 PSI, 60 HP.
2—Sweetland #12 pressure filters,
6—Shriver 48" Cast Iron P. & F. filter presses, (50) chambers, hydraulic closure, closed deliv.
2—19,900 sq. ft. quadruple effect calandria type evaporators, copper tubes, cast iron bodies.
6—Ansonia 691 sq. ft. dbl. pipe coolers, copper tubes
3—American 654 sq. ft. spiral steel heat exchangers
18—Tubular heat exchangers, copper tubes: 1500, 1350, 1130, 637, 380, 290, 184, 176, 156 sq. ft.
4—Leader Iron 96" dia. steel rectifying columns, 44' & 51' high.
2—9500 gal. horiz. cookers, 9' dia. x 20' long, ½" shell & heads.
5—Forster hammermills, #8 & #6
2—Allis-Chalmers Inter-plane grinders, 100 HP
9—Davenport 5' x 25' screens
2—Warren 12" x 12" cent. pumps
250—Steel centrifugal pumps, 1" to 12", 1 HP to 150 HP
2—Aldrich vert. triplex plunger piston-type pumps, steam drive, 162 GPM @ 175# WP.

SEND FOR CIRCULAR #960-A

PERRY EQUIPMENT CORP.
1413-21 N. Sixth St.
Philadelphia 22, Pa.
Phone POplar 3-3505

CIRCLE P ON READER SERVICE CARD

BEST BUY

DORRCO CLARIFLOCCULATOR

In Stock

60' dia x 10' SWD Ser #10803 Complete with Westinghouse 3 HP Class III Gear Motor. Dorr Duplex Rubber lined Diaphragm Pump, heavy I beam supports and overload alarm. Very excellent condition.

Tremendous Saving

ME MACHINERY & EQUIPMENT CO.

CIRCLE Q ON READER SERVICE CARD

JUST PURCHASED

1—Fletcher 30" under driven "Junior" Stainless extractor
1—Gemco 60 cu. ft. cone blender, T304 SS
1—DeLaval #ACVO Stainless cent.
1—Allis 7' x 120' kiln, ¾" welded.
1—Allis-Chalmers 5' x 5' ball mill, 75 HP.
5—F. J. Stokes #138-J6 vacuum shelf dryers, 16 shelves 40" x 44", 195 sq. ft.
6—Valley 36" aluminum P. & F. filter presses, 65 chambers, closed delivery, hydraulic closure.
1—Vulcan 60" dia. x 35 plate T316SS bubble-cap column, 42' high, Vacuum.
1—Hardinge 8' x 48" conical pebble mill, air swept, classifiers.
1—Buflovak 32" x 52" double drum dryer, ASME 100# WP.
1—American 42" x 120" double drum dryer, ASME, stainless trim.
2—500 gal. T304SS jacketed reactors, ASME, Vacuum, UNUSED.
2—8' x 56' rotary kilns, ½" welded.
4—1350 gal. T347SS jkt. kettles, paddle agit., open top.

STAINLESS STEEL TANKS

1—5700 gal., T304SS, horiz., 6'-4" x 24', UNUSED.
2—4500 gal., T304SS, 8' x 12', UNUSED.
1—4300 gal., T304SS, 6' x 20', ASME 50# WP.
1—3700 gal., T304SS, 6' x 17', Coils.
1—3400 gal., T304SS, 6' x 16', dishd.
1—3300 gal., T304SS, 6' x 14', dishd.
1—3200 gal., T304SS, 6-6" x 12' coils.
3—2750 gal., T316SS, 7' x 8', dished heads, int. coils.
2—2300 gal., T316SS, 7' x 8', coils, flat bottom, Agit.
3—2250 gal., T316SS, 7' x 6'-3", Agit.
1—2100 gal., T316SS, 6' x 9'-10", open top, cone bottom.
1—1750 gal., T304SS, 5' x 12', coils.
12—1750 gal., T304SS hoppers, 235 cu. ft.
1—1600 gal., T304SS, 5' x 11', dished.
1— 800 gal., T316SS, 5'6" x 4'6".
6— 685 gal., T316SS, 3' x 10' coils.
1— 600 gal., T304SS, 5' x 4', dished.

PHILADELPHIA—

HEADQUARTERS FOR

PROCESS EQUIPMENT VALUES

EVAP. — STILLS COLUMNS — CONDENSERS

7—4050 sq. ft. calandria type evap., copper tubes, cast iron shell & heads.
1—Mojonnier 2085 sq. ft. triple-effect Stainless Sanitary evaporator.
4—Buflovak double-effect stainless evap. vert. long-tube type: 1025, 840, 710, 588 sq. ft.
1—Stokes 118 sq. ft. T316SS U-tube still.
1—Bartlett & Snow 6' dia. Stainless jkt. evap.-crystallizing kettle.
1—Vulcan 110" dia. x 16' high T316SS bubble-cap column, 10 trays.
1—96" dia. x 44' high steel beer still.
1—Vulcan 60" dia. x 42' high, T316SS bubble-cap column, 35 trays.
1—60" dia. x 16' high T316SS bubble-cap column, 10 trays.
1—36" dia. x 9'-8" T316SS bubble col.
15—Copper bubble-cap columns, 24" to 54" dia., to 51' high.
1—1960 sq. ft. T316SS exchanger, remov. bundle, ASME 75# WP.
1—1450 sq. ft. T316SS condenser.
5—1400 sq. ft. T316SS gas converters.
3—800 sq. ft. T316SS condensers.
1—730 sq. ft. T316SS exchanger.
6—691 sq. ft. copper Dbl. pipe coolers.
1—510 sq. ft. T316SS condenser.
30—T316SS condensers & exchangers: 427, 425, 410, 400, 290, 277, 264, 250, 200, 185. 165, 150, 145, 105, 83, 73, 54, 52, 50, 47, 30 sq. ft.
12—185 sq. ft. T304SS U-tube coolers.

PRESSES

5—Davenport #1A dewatering presses.
4—Davenport #2A dewatering presses.
2—Davenport #3A dewatering presses.
2—Komarek 160,000 PSI briquette presses.
2—French Oil #2-S screw type extraction presses, 300 PSI, 60 HP.
2—Stokes #DDS-2 rot. tablet presses.
1—Stokes #RD-3 rot. tablet press.
1—Stokes #T single punch press.

FILTERS—CENTRIFUGALS

6—Shriver 48" C.I. P&F filter presses, 1000 sq. ft., closed delivery
6—Valley 36" aluminum P&F filter presses, 65 ch., closed delivery.
5—Sweetland #12 filters, (72) stainless leaves, open deliv.
1—Sperry 30" Ni-Resist P&F filter.
1—Niagara #510-28, T316SS filter.
1—Oliver 5'3"x8' precoat rotary vacuum filter, UNUSED.
2—Oliver 5'3"x3' precoat rot. vac. filter, T316SS, ASME 30# WP.
1—48" Tolhurst susp. cent., T304SS.
5—40" A.T.&M. susp. cent., T304SS.
2—32" A.T.&M. susp. cent., T304SS.
1—12" A.T.&M. susp. cent., T304SS.
30—Sharples #AS-16V super cent., Inconel, vapor-tite, sludge-disch. frame.
2—Sharples #16-P super cent., T304SS, pressure-tite.
2—Sharples #C-20 Super-D-Hydrators, T316SS.
1—Bird 32"x50" contin. cent., T316SS.

DRYERS—KILNS

1—Vulcan 10' x 11' x 175' rotary kiln.
2—10' x 78' rot. dryers, ¾".
2—Hardinge 8'-8" x 70" rotary, ⅜".
1—Traylor 8' x 80' rotary, ⅜".
2—Davenport 8' x 60' rotary, 7/16" welded, burners, fans, etc.
1—7'-6" x 62' rotary kiln, ½".
2—Bonnet 7' x 60' rotary, ⅜".
1—Bonnet 6' x 52' rotary, 5/16".
1—Louisville 4'-6" x 25' steam-tube.
5—Buflovak 42" x 120" double drum dryers, ASME 160# WP.
1—Buflovak 42" x 90" Dbl. drum.
2—American 36" x 84" Dbl. Drum dryer
1—American 36" x 84" double drum dryer, ASME, VACUUM.
1—Buflovak 5' x 12', single drum dryer, Vacuum UNUSED.
1—Buflovak 6" x 8" dbl. drum.
5—Stokes 195 sq. ft. vac. shelf.
2—Buflovak vac. shelf: 110, 98 sq. ft.
1—Bowen Stainless lab. spray dryer.
1—Turbulaire Stainless spray dryer.
1—Nerco-Niro stainless spray dryer.

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24"x17'-24 cap trays
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48"x25'-35 cap trays
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S.S. Centrif Pumps 2", 1½", 1"
Norwalk Compressor 15000 PSI
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4000 gal. Vert. w/coils
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1200 gal. 5'x8' Agit
900 gal. 5'x6'
750 gal. 5'x5' Agit
500 gal. 3'6"x8' Agit
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300 gal. 4'x3' Cone bot
150 gal. 3'x3' Agit.

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1—Raymond 36" Double Whizzer Separator.
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2—Theo. Walters 300 gal. Hastelloy B jacketed reactors
1—Van Alst 300 gal. stainless steel jacketed kettle
1—Blaw Knox 300 gal. stainless steel vacuum reactor
1—Struthers Wells type 316 SS 2000 gal. jacketed reactor
2—Blaw Knox steel 600 gal. autoclaves

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2—Bonnet rotary kilns, 8' x 115', complete
1—Bonnet rotary cooler, 8' x 50', complete
1—Allis Chalmers stainless steel rotary dryer, 6' x 50', complete
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
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2—Buflovak stainless steel rotary vacuum dryers, 5' x 30'
1—Hersey rotary dryer, 3' x 20', complete
1—Buflovak SS jacketed rotary vacuum dryer, 3' x 15'
2—Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
1—American 42" x 120" double drum dryer, ASME, complete
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1—Fletcher 48" SS underdriven centrifuge, complete
7—Western States 40" type 316 SS suspended type centrifuges
1—AT&M 26" type 316 SS suspended type centrifuge, complete
5—Tolhurst 40" and 30" rubber covered centrifuges

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1—Oliver horizontal filter, 3'
1—Oliver stainless steel rotary vacuum filter, 3' x 4'
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
10—Shriver plate and frame filter presses, 12" to 42"

MIXERS

1—Banbury #1 mixer with 30 HP motor
1—Sturtevant #7 dustite rotary batch blender, NEW

THE GELB GIRL—MARCH 1961

15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Robinson type 304 SS horizontal double ribbon blender, 125 cu. ft.
1—Baker Perkins, Size 16, Type UUEM, 150 gal. jacketed, double arm dispersion type mixer, complete with compression cover and 100 HP motor
1—Baker Perkins SS double arm sigma blade mixer, 9 gal.
1—J. H. Day 5 gal. double arm sigma blade mixer, SS
1—Stokes stainless steel granulating mixer, Model 21-J
1—Colton stainless steel granulator, Model 561-S

MISCELLANEOUS

1—Williams "Comet" 4 roll mill, complete
1—Raymond 2 roll high side mill
1—Stewart Bolling 2 roll chrome plated, plastic mill, 8" x 16"
1—Ross 6 "x 14" 3 roll paint mill, high speed, complete
1—Vulcan stainless steel bubble cap column, 4' x 25 plates
1—Badger SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with trays
1—Griscom Russell SS heat exchanger, 900 sq. ft.
1—Downington SS heat exchanger, 750 sq. ft.
3—Badger SS heat exchangers, 500 sq. ft. and 600 sq. ft.
4—Patterson SS condensers, 200 and 300 sq. ft.
20—Davis Engineering SS heat exchangers, 102, 119, 136, 166 sq. ft. NEW
2—Davis Engineering Carpenter 20 heat exchangers, 120 sq. ft.
2—Swenson SS vacuum crystallizers, 3'6" x 12' and 2' x 12'
3—Mikro #1SH pulverizers, complete
1—Mikro #2TH pulverizer, complete
2—Mikro #3TH SS pulverizers, complete

1—Raymond #5057 high side five roll mill
1—Cleaver Brooks 500 HP package steam generator, 200#
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2—Pfaudler type 316 SS jacketed reactors, 200 and 100 gal.

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Popular thinking on any subject is often like a pendulum, swinging forward in sheer exhilaration over an exciting idea, then backward to a cynical attitude against it. Years ago, health columnists extolled the nutritive qualities of spinach. Shortly thereafter, it was equally popular to decry spinach as an over-glamorized weed.

This vacillation springs from the efforts of spokesmen to capture interest, and the tendency of many people, like wild creatures in the forest, to give attention to whatever is moving regardless of the direction. That is why it sometimes seems that the more preposterous an idea the more credence it receives.

After World War II, supervisor and management development became extremely popular. Some of these programs naturally fell short of expectations, and there are always detractors — ready to display their intellectual brilliance by speaking cynically of *all* types of human relations training. Real progress in supervisory methods has, therefore, been slow.

Supervisory personnel, continually aware of the intrinsic values of human relations, are the key to uninterrupted production, completion of projects successfully and on time, for they forge the links in the productive chain solidly together.

Your management is interested not only in the creative, bold steps you would take into unknown solutions to problems, but also in how quickly and productively (profitably) you can put these ideas into practical application. When the solution, or idea, leaves your desk and starts down the long line of being put into practice, the supervisors throughout that chain of action will determine to a great extent whether their individual components will function properly or whether a project will bog down under the weight of misunderstanding and apathy.

It is extremely important, therefore, to maintain good supervisory practices throughout the various departments through which the original concept must be translated. It means a thorough understanding of human relations yourself, and the ability to communicate this understanding and appreciation to the supervisory personnel under you. This can and probably must be done both by individual contact with your supervisors and/or by conducting actual courses of study on the subject.

FOOTNOTE: the foregoing paragraphs are a direct quotation from another of Western's "personal-professional development" series, Booklet E-7, titled "Supervision — for Professional Advancement" a copy of which is yours upon request, without obligation. Write to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. Box 1888, Tulsa, Okla. — **where supervision contributes greatly to the manufacture of heat exchangers of the highest quality, and where personal attention to detail is our watchword.**

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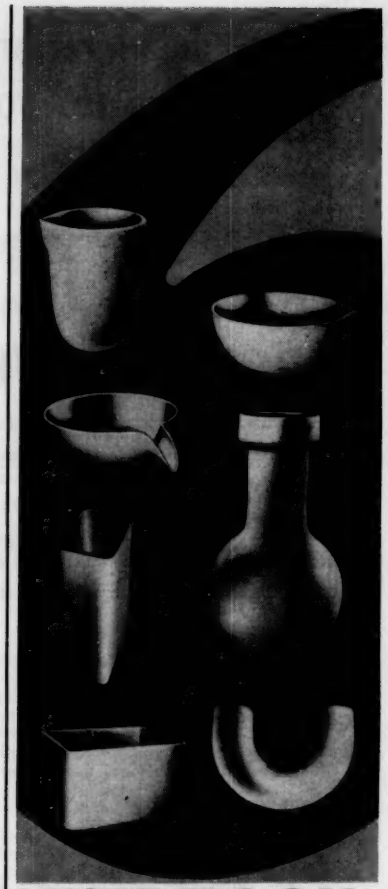

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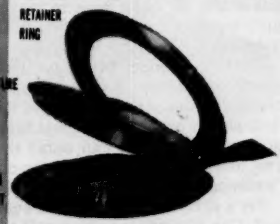

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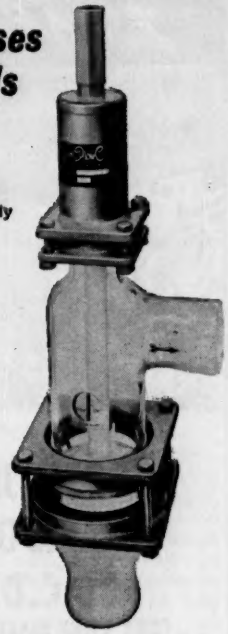

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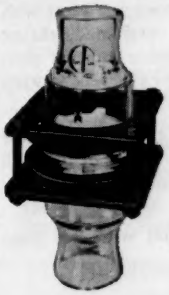

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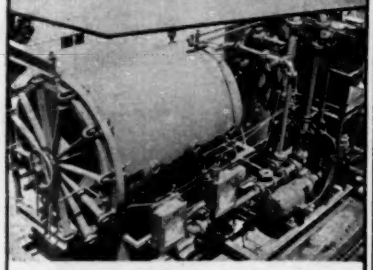

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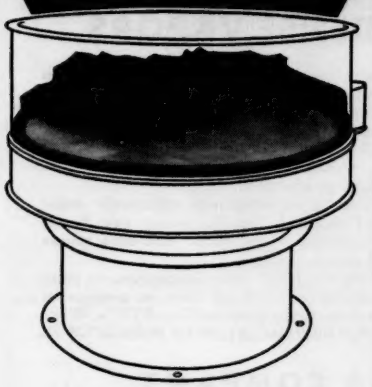

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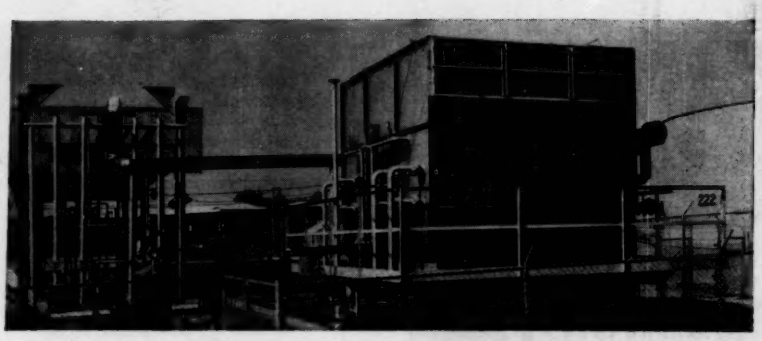

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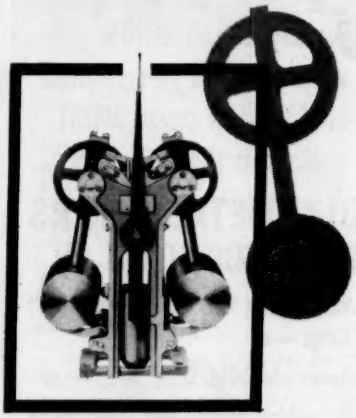

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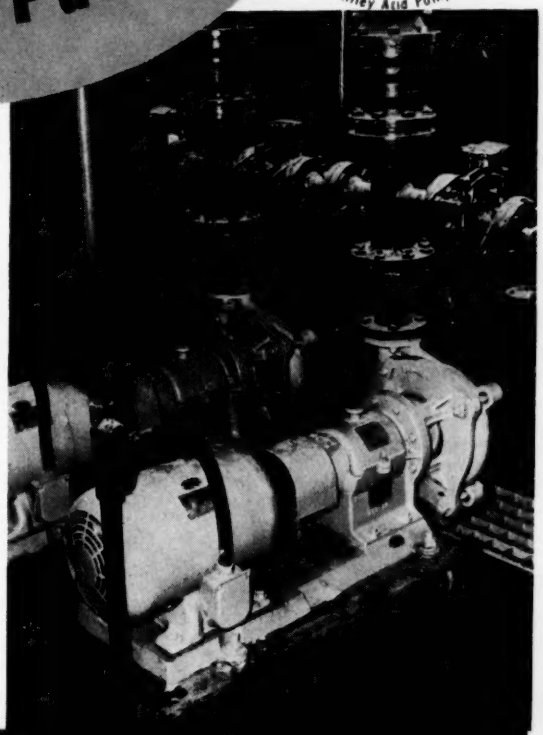

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